St. Lawrence River Bridge.

GENERAL SPECIFICATION FOR THE CONSTRUCTION OF THE ST. LAWRENCE BRIDGE, AND APPROACHES.

Extent of the Work.—This specification refers to all works required for the construction of that portion of the Atlantic & North-West Railway between a point, (station 300) near the Cote St. Luke Road, on the Island of Montreal, and a point, (station 524) on the east side of the River St. Lawrence, about one mile east of the east abutment of St. Lawrence Bridge, a distance of about 4¼ miles.

2. *Works to be Done.*—The works to be done are shown on the general and detailed plans, and comprise clearing, grubbing, fencing, earth excavation, rock excavation, masonry, rip-rap, construction and erection of superstructure, and all other work necessary, to fully complete a single track railway up to subgrade, between the above mentioned points.

3. *Clearing and Close Cutting*—Where the line passes through wooded land, the entire right of way must be cleared, and all timber, brush and stumps, etc., must be either burned or removed from the right of way. No timber, brush, stumps or roots, shall in any case be piled upon adjacent lands, and where embankments are less than five feet, all stumps must be cut close to the ground.

4. *Grubbing.*—Where the excavation is less than three feet or the embankment less than two feet, the ground must be grubbed and all roots taken out and burned.

5. *Fencing.*—The posts must be all of round Cedar not less than five inches at the small end. They must be straight and neatly dressed with the bark all removed. They must be placed 4 feet in the ground with the large end down, four feet six inches above ground, and eight feet center to center. The fence must be made with four strands of the best galvanized barbed wire, which must be strained taut and securely fastened to the posts, and one board 5" wide by 1¼ inch in thickness. Braced posts as shown by the detailed plans must be placed at distances not exceeding three hundred feet apart. All farm crossings must be provided with gates similar to those in use on the completed portion of the line.

GRADING.

6. *Earth Excavation.*—Earth excavation must be taken out to a width of at least 46 feet at subgrade, so as to have a roadway of 16 feet in width in the center of the cutting, after ditches, 3 feet deep and 6 feet in width at the bottom, have been excavated on each side through the cutting, as shown by cross section (A) on the profile. The cutting between stations 324 and 351 must be excavated to a sufficient width, as directed by the chief engineer to obtain material with which to form the embankments between stations 351 and 400. An extra right of way has been purchased by the Company, in order to permit of this extra width of excavation being made.

7. *Embankments.*—All embankments must be made 16 feet at subgrade, and of such height as will leave them of the required elevation after settlement has taken place. The slopes will generally be 1¼ horizontal to 1 perpendicular, but in case the material is of such a nature as to take a flatter slope, then this slope must be given to the embankment so as to leave it at the proper width at the top.

8. *Rock Excavation.*—Should rock be found in any of the line cuttings, the contractor will be required to excavate it to such a section as the engineer may require; any stone, found fit for masonry or rip-rap, may be used for such, by the contractor, all other stone must be deposited in embankment as indicated by the chief engineer, The contractor will be paid his schedule price per yard, for all material that the chief engineer may require him to remove; any further quantity will not be paid for. Any material loosened by powder beyond the line of slope must be removed, but will not be paid for. The material to be placed in all embankments must be approved of by the chief engineer, who shall have the right to vary the slopes, to suit the character of the material of which they are to be built.

9. *Formation of Embankments, etc.*—The whole of the grading must be carefully formed to the levels given, and the roadway both in cutting and embankment must be carefully rounded and left six inches higher at the center than at the sides. In rock cuttings it will be sufficient to form a water channel 2 feet wide and 8 inches deep along each side. All materials found in excavation, whether in road-bed, cuttings, ditches, water channels, road crossings or elsewhere, to be deposited in such places as the chief engineer may direct.

10. *Catchwater Ditches.*—Catchwater ditches must be made along the tops of excavation, where required, to keep water from flowing into cuttings, as well as all other drains the engineer may consider necessary for the proper drainage of embankments and cuttings.

11. *Contractor to Furnish his own Borrow Pits.*—The excavation on the south side of the river, will not be sufficient to form all the embankment required, but it is to be understood that the contractor must furnish his own borrow pits on that side of the river, and to be at the expense of placing all the material, in the position required, for the price named in the schedule.

12. *Classification of Work on Line.*—Excavation on the line of roadway will be classed under two heads, earth and rock. Rock will embrace stone that is found in solid masses, that requires blasting to be removed, and also all boulders, found in the excavation, of half a cubic yard and upwards. All other excavation, on the line of railway, except excavation in foundations, will be classed and paid for as earthwork.

13. *Classification of Borrow Pits.* All material taken from borrow pits, that is required to complete the embankments, no matter what it is composed of, will be classed and paid for as earth work.

TRESTLE WORK.

14. *Timber Trestle Work.*—The trestlework must be built in strict accordance, in every detail, with the plans to be furnished.

15. *Quality of Timber.*—All the timber must be of good, sound white pine, free from all black knots, worm holes, decayed wood, shakes, or any defect that will, in the opinion of the chief engineer, impair its strength or durability, it must be sawn square, and out of wind, and be of the exact dimensions shown on the plan.

16. *Framing.*—All framing must be made to fit closely, and must be done in a thorough workmanlike manner, no open joints or filling pieces will be allowed.

17. *Painting Joints.*—All surfaces, where wood touches wood, must be thoroughly painted, before being put together, with a good thick coat of white lead.

18. *Stringers.*—The stringers must be of the best class of white pine, and must, in addition to the requirements above mentioned, be free from all sap, knots, or anything else that would impair their transverse strength.

19. *Price.* The work will be paid for at the rate of so much per 1000 feet B. M. of timber, and at so much per pound for the iron work.

RIP-RAP, ETC.

20. *Rip-rap Hand-laid.*—Embankments at such points as may be designated, will be protected with hand-laid rip-rap, which is to have a thickness of three feet at the ground, and two feet at the top, the stones are to be placed on edge at right angles to the slope of the embankments, no stones are to be used having a less depth than 18 inches. The top of the work is to be finished with a coping 2 feet deep, having a face width of nine inches, and to be not less than three feet long.

21. *Rip-rap at Certain Piers.*—Such piers as the chief engineer may direct, are to be surrounded with ordinary loose rip-rap, to such a height and width as he may consider necessary.

COFFERDAMS, ETC.

22. *Coffer Dams and Caissons.*—The contractor will be allowed to adopt any plan for his cofferdams that he may desire, providing he is able to lay the foundations of the piers dry, so as to properly level off the rock to receive the masonry, He will also be allowed, where the rock is considered suitable by the chief engineer, except in the Lachine Canal, to sink a bottomless caisson, fitted closely to the rock, into which he can deposit Portland cement concrete, to a depth not exceeding one-third of the depth of the foundations from the surface of the water. When this concrete is properly set, the caisson may be pumped out, and the masonry commenced from its surface, after it has been properly levelled and prepared.

23. *Surface of the Rock where it is Inclined.*—Where the surface of the rock is smooth and inclined, so that the piers would, in the opinion of the chief engineer, have a tendency to slide upon it, the contractor will be required to level, step or roughen, as the chief engineer may consider necessary, the surface of the rock, so as to make it a secure and safe foundation on which to deposit the concrete or build the masonry.

24. *Mode of Depositing Concrete.*—Where bottomless caissons are used, particular care must be taken in depositing the concrete, so that it will not fall any distance through the water. It must be deposited in a covered box, of approved pattern, holding about two cubic yards, and when the box of concrete is placed in the bottom, the box must be drawn up from the concrete Care must be taken that no hollow places are left in any portion of the caisson, and divers must be sent down, to see that all angles and spaces around timbers, are properly filled and packed.

25. *Cost of Work in Foundation.*—It is to be understood that the cost of all caissons and cofferdams, or other modes of putting in the foundations of the piers and abutments, as well as all pumping and bailing, and all dressing or preparing the surface of the rock or the surface of the concrete or masonry, or any other work or material that may be required in connection with the foundation, is to be included in the price of the masonry and that nothing whatever will be paid on account of any labor, or material put in cofferdams or caissons, or on account of removing boulders, or any other loose material from the surface of the rock, or on account of any plant, labor or material, required to place the dams or caissons in position, or to keep them dry, except the schedule price for the earth or rock excavated in, or removed from, the bed of the river.

26. *Soundings not Guaranteed.*—The soundings and borings, shown on the plan, exhibited with this specification, are believed to be accurate, but should any errors be found hereafter during the prosecution of the work, the company will not be liable for any extras or claims on account of increased or diminished work. The company will only pay the respective schedule rate, for the amount of earth or rock excavation that may be necessary to prepare a suitable foundation, and will not allow any extras, on account of an increased or diminished depth of water, or on account of an increased or diminished quantity of excavation, or increased or diminished quantity of masonry, that may be required to bring the piers or abutments up to the required height.

27. *Concrete.*—The concrete must be composed of Portland cement, that will stand the prescribed test, of good, clean, sharp, river sand, and broken stone that will pass through a two inch mesh, in the proportion of one part of cement, one part of sand, and as much stone as the above mortar will take, so as to completely fill all the voids in the stone. This concrete must be thoroughly mixed till each stone is thoroughly coated with mortar, and then allowed to set to a slight extent, before being deposited in the caissons. Concrete will be paid for, at so much per cubic yard, measured in the work.

MASONRY.

28. *Class of Masonry.*—The masonry will be of the class known as Rock faced Ashlar, and must be first-class in every respect.

29. *Quality of Stone.*—The stone to be used in the abutments, piers, arches, etc., must be of the best quality, and in every way suitable for the purpose for which it is to be used. It must be sound and durable, free from all drys, shakes, or flaws of any kind whatever and must be of such a character as to withstand the action of the weather. No stone of an inferior quality will be accepted, or even permitted to be delivered upon the ground.

30. *Dressing Bed and Joints.*—The beds of all stone for face work, and the backing where required to receive headers, must be dressed parallel throughout, so as to form quarter-inch joints, and the vertical joints of the face stones must be dressed back square for nine inches, so as to form quarter-inch joints.

31. *Coping to be Chisel-dressed.*—The coping stones, chamfers, arrises and cutwaters, must be neatly chisel-dressed, as shown in the detailed plans and as directed during the progress of the work.

32. *Arch Stones.*—If arches are built, the arch stones must be cut so that when laid their ends will radiate truly from the center of the circle, they must be dressed to the full depth of the bed, so as to give truly radiated joints, so that when set no joint will exceed one-quarter of an inch. All end joints must be dressed square, arch stones must not have a less length than 27 inches, and must break joint by at least 10 inches. Their thickness at the soffit must not be less than 12 inches, and the soffit must be neatly dressed to the circle, or at least 1¼ inch on each side the longitudinal joints. The outer ring stone must be neatly worked with a chamfer and chisel draft around their edges.

33. *Arch Centres.*—The centres of the arches must in all cases be well formed, of ample strength, and securely placed in position. The ribs must not be further apart than three feet, and the lagging must be three inches square, The support of the centres must be strong and substantial, and they must be provided with proper wedges for easing the centres when required.

34. *Thickness of Courses.*—The masonry in the bridge abutments and piers must be of the best and largest stones that the quarry will afford. No course less than 15 inches in thickness will be allowed. The arrises must be chiseled four inches in width, and must be left perfectly true from top to bottom to the batter required, and in no case will a thick course be allowed to be laid over a thinner one.

35. *Headers.*—Headers must be built in every course not more than six feet apart, and so arranged with the adjoining courses as to leave them equally distributed over the faces of the structure, They must have a length in the face of work of not less than 24 inches, and a depth of at least 2¼ times their height, unless the wall will not allow this proportion, in which case they must pass from front to back. In the abutments, where the headers do not pass through the wall, they must be built in from the back and front alternately.

36. *Stretchers.*—Stretchers must not be less than 30 inches, nor more than 72 inches, in length, and their breadth must be at least 1½ times their height. The vertical joints must be so arranged, as to overlap those in the course below at least 10 inches, for the 15-inch courses, with one inch additional lap for each three inches increased thickness of course.

37. *Cut Waters.*—The cutwater stones must be arranged as shown in the detailed plans. The vertical joints must all be dressed back square to the full depth of the stone. Iron clamps of the required dimensions with bolts passing through them, down through one course and one-half of masonry, must be let into the stones in the manner shown in the plans, and the holes filled in with neat cement.

38. *Backing Beds and Joints.*—The beds of the backing must be pointed off where headers are to be placed. The vertical joints of the backing will generally be left as they come from the quarry, unless they should be found of such a nature as to make the joints average more than two inches in width, in which case they must be hammered off, so as to make the joint

the required width. Care must be taken in arranging the backing, so as to afford proper ties for the headers, and to get the stones as close together as possible.

39. *Size of Backing.*—The backing, generally, must have an area of bed of at least four superficial feet. In every case the beds under headers must make joints equal to the face work and no pinning of any kind will be allowed under bottom beds. Where headers do not come, the courses need not be levelled off, but may project into the course above.

40. *Face of Work.*—The work must be left with a clean quarry face, free from all rust or other stain, and in no place must the rock face project more than four inches beyond the line of pitching above the water level, nor more than two inches under the water level. The east and west face stones under water, in the Lachine canal pier, must be pointed off and the face left smooth.

41. *Time When Work may be Commenced.*—No masonry shall be commenced before the chief engineer shall have examined and approved of the foundations, nor until the contractor shall have provided appliances and material of such a kind as shall be approved of by the engineer.

CEMENT.

42. *Quality of Cement.*—All masonry shall be laid in freshly ground Portland Cement of approved brands. It shall not weigh less than 110 pounds, to the struck bushel, nor shall less than 80 per cent. pass through a sieve containing 2,500 meshes per square inch, and the tensile strength of neat cement, kept in water at a temperature of 60° Fahrenheit, at the end of seven days shall not be less than 250 pounds to the square inch. It shall be tested by the engineer on delivery, and shall be kept in a dry place, in as good order as when delivered till used.

43. *Proportion of Sand to Cement.*—The cement must be thoroughly mixed with good clean, sharp, coarse grained river sand, generally in the proportion of one part of cement to two parts of sand by measure. The cutwater stones and coping shall be laid with mortar in the proportions of one part of cement to one of sand.

44. *Mixing Cement.*—The cement shall only be mixed as required, any cement mortar left over at noon or at night shall not be used, and it must be prepared by the contractor's men under the supervision, and to the satisfaction of the inspector, failing which the inspector, with the sanction of the chief engineer, may employ men to prepare the mortar, and the expense incurred shall be charged to the contractor and deducted from his estimate.

45. *Grouting.*—Every stone must be laid with a full bed of cement mortar, and beaten solid: spaces in the vertical joints, large enough to be built must be built up and all other vertical joints must be thoroughly grouted and each course finished off perfectly solid.

46. *Pointing.*—All the work must be carefully pointed with neat cement, and at the completion of the contract the work must be left in neat, clean and workmanlike condition, to the satisfaction of the chief engineer.

47. *Removal of Coffer Dams.*—All coffer dams, outer caissons, and other materials (of such a nature as to obstruct the flow of water), that have been put in the river by the contractor, shall be removed at his expense as soon as the structure for which it was used has been completed.

48. *Filling Round Abutments.*—No earthwork shall be filled around abutments till at least two weeks after the masonry has been laid, and the earth must be carefully punned in thin horizontal layers around the walls.

49. *Coping Stones.*—The coping of all piers and abutments shall be of the best stone to be found in the quarries, and shall not be less than twenty-four inches in thickness; shall be dressed square throughout to quarter inch joints, and shall be laid perfectly level.

50. *Girder Beds.*—The girder beds shall be twenty-four inches in thickness, and for the piers shall be through stones; they shall not be less than thirty-six inches in width, and shall be so arranged that the girders shall set fairly on the middle of the stones.

51. *Price of Masonry.*—It is understood that the price for masonry put in the schedule is to cover the cost of all materials, plant and workmanship necessary for the construction of masonry, as well as for the construction of the coffer dams, caissons, and all pumping or bailing, and any other work required to found the piers and abutments in a sound and substantial manner upon the rock in the bed of the river, and that no extra price will be paid for any work that may be required to secure this object. The plans and profiles of the bottom of the river have been prepared from careful soundings, but the company will not be responsible for their accuracy. The contractor must satisfy himself on this point, and it is to be fully understood that no claims for extras will be permitted on account of any inaccuracy in the plans, and that the contractor shall have no claim for extras, on account of any increased or diminished quantities of masonry on any pier or abutment, or on account of any increased or diminished depth of water on the site of any of the piers or abutments; he shall only be paid for the actual quantities at the schedule rate.

IRON OR STEEL SUPERSTRUCTURE.

52. *General Description.*—The superstructure required is 1°. For a girder of 50' clear span over the Grand Trunk Railway; 2°. for a draw span over the Lachine Canal, which is 160 feet in width on the square, and 180 feet on the skew as the line now crosses; the position of the centre pier is not yet fixed, but tenders will be taken for the centre pier in the centre of the canal, as well as for the piers on the shore 10' from the bank; 3°. For the bridge over the St. Lawrence river, which has a width of about 3,300 at the point of crossing. The channel span must be 330 feet in the clear, and have a clear elevation of 60 feet above ordinary summer water. The deck spans must be at least 16 feet wide centre to centre of chords, and the through spans at least 20 feet in the clear.

53. *Length of Spans.*—The plans show the piers of the bridge over the St. Lawrence, arranged in two different ways: No. 1 arrangement has eight spans of 242 feet centre to centre of piers, two spans of 269 feet 10 inches centre to centre, and two spans of 408 feet. No. 2 arrangement has nine spans of 268 feet, two spans of 269, and one span 340 feet center to centre; but tenders and plans will be received for any other arrangement, providing the position of the east pier of the channel span is not changed, and that no piers are placed closer than 242 feet centre to centre.

54. *Tenders.*—The tender must be:

First. For a lump sum for the superstructure delivered on the ground.

Second. For a lump sum for the superstructure erected, with floor timbers in position ready for the rails.

55. *False Works.*—All timber for the false work must be furnished by the contractor. Prices must cover all materials, labor, customs duties, transport, plant, and everything required for the construction, erection and entire completion of the bridge in a permanent position ready for laying the track, except the ties and guard rails, which will be furnished by the company, but must be placed in position by the contractor.

56. *Plan in Full Detail.*—The elevation of the several piers, depth of water, etc., is shown on general plan and profile No. 1 and tracing No. 2, and contractors are required to show on their plans, the general arrangement of the spans, complete strain sheets with full details showing the dimensions of all parts, modes of construction and the sectional areas.

57. *Steel or Iron.*—Tenders may be for the construction of the bridge of either steel or wrought-iron, or partially steel and partially wrought-iron. All tenders to be strictly in accordance with the requirements of this specification as to strength and dimensions of parts, quality of material and workmanship to be employed. Deck spans to have four lines of stringers, and through spans, six lines; other arrangements of floor may be given in addition, to the above, and a separate price named.

58. *Weight.*—All tenders for the superstructure shall in addition to the lump sum price, state the weight of each span according to the design shown, and also the price per pound which makes the lump sum. If the finished weight of the bridge is less than that stated in the tender, a reduction shall be made, based on the number of pounds which it is less than the weight put in the tender, valued at the price put in the schedule. Any excess of weight will not be paid for. No member of any span will be allowed to be of less dimensions than shown on the plans, or than is required by the strain in that member.

59. *Loads.*—The several spans must be proportioned to carry in addition to the dead load, two consolidation engines coupled as shown in the above diagram, followed by a train load of 3,000 pounds per lineal foot, and the maximum strains due to all positions of the live load must be taken in proportioning all the parts of the structure. Floor to be laid with 8" x 8" white pine ties spaced 12 inches, centre to centre, with two guard-rails on each side of the track, one 6" x 6" and the other 10" x 10".

Temperature.—Variations in temperature to the extent of 180 degrees Fah. must be provided for.

60. *Tensile Strain.*—All parts of the structure shall be so proportioned that maximum loads shall in no case produce a greater tension strain upon the net section than the following:

		Pounds per square inch.
On bottom chords and diagonals	iron	10,000
" " " "	steel	12,000
On counter rods, long verticals, and end lower chords	iron	8,000
On counter rods, long verticals, and end lower chords	steel	10,000
On lateral bracing (with 10,000 pounds initial strain)	iron	15,000
On lateral bracing (with 10,000 pounds initial strain	steel	18,000
On bottom flange of riveted floor beams	iron	8,000
" " " " "	steel	10,000
On bottom flange of longitudinal plate girders (over 20 feet.)	iron	8,000
On bottom flange of longitudinal plate girder (over 20 feet.)	steel	10,000
On bottom flange of longitudinal plate girder (under 20 feet)	iron	7,000
On bottom flange of longitudinal plate girder (under 20 feet)	steel	9,000
On suspension loops or other members liable to sudden loading	iron	6,000
On suspension loops or other members liable to sudden loading	steel	7,000
On solid rolled beams	iron	8,000
" " "	steel	10,000

61. *Compression Strain.*—Compression members shall be so proportioned that the maximum load shall in no case cause a greater strain than that determined by the following formula:

$$P = 1 + \frac{\frac{8000}{L^2}}{40{,}000\ R^2}$$ for square and compression members,

$$P = 1 + \frac{\frac{8000}{L^2}}{30{,}000\ R^2}$$ for compression members one pin end and one square end.

$$P = 1 + \frac{\frac{8000}{L^2}}{20{,}000 R^2}$$ for compression members with pin ends.

P = Allowed compression per square inch of cross section.

L = Length of compression member in inches.

R = The least radius of gyration of the section in inches.

For steel substitute 10,000 for 8,000 *in formula.*

No compression member shall have a length exceeding 45 times its least width.

62. *Rolled Beams.*—In rolled beams and girders compression shall be limited as follows:

		Pounds per square inch.
In rolled beams used as floor beams or stringers	iron	8,000
In rolled beams used as floor beams or stringers	steel	10,000
In riveted plate girders used as floor beams, gross section	iron	7,000
In riveted plate girders used as floor beams, gross section	steel	9,000
In riveted longitudinal plate girders (over 20 ft) gross section	iron	7,000
In riveted longitudinal plate girders (over 20 ft) gross section	steel	9,000
In riveted longitudinal plate girders (under 20 ft) gross section	iron	6,000
In riveted longitudinal plate girders (under 20 ft) gross section	steel	8,000
In riveted lattice girders gross section	iron	7,000
" " " "	steel	9,000

63. *Alternate Strains.*—Members subject to alternate strains of tension and compression shall be proportioned to resist each kind of strain. Both of the strains shall be assumed to be increased by an amount equal to $\frac{3}{8}$ of the least of the two strains for determining the sectional areas, by the above allowed strains.

64. *Wind Strains.*—To provide for wind strains the top lateral bracing in deck spans and the bottom lateral bracing in through spans, shall be proportioned to resist a lateral force equal to 30 pounds per square feet, on the surface of the train averaging 12 square feet per lineal foot and also on the vertical surface of one truss; the 360 pounds pressure from the train surface to be treated as a moving load, and the pressure on the bridge surface as a fixed load. The bottom laterals in deck spans and the top laterals in through spans shall be proportioned to resist a lateral force equal to 50 pounds per square foot upon the vertical surface of one truss.

65. *Strain from Wind Pressure.*—The strain in the chords from the assumed wind force arising from wind displacement (capsizing) and direct wind (transverse) strain will only be taken into account when they exceed one quarter of the maximum fixed strain for dead and live loads. The sections shall then be increased until the total strain per square inch will not exceed by more than one quarter the maximum fixed for dead and live loads only.

66. *Shearing of Rivets. Bolts.* The rivets and bolts connecting the parts of any member must be so spaced that the shearing strain per square inch shall not exceed 7,500 pounds, or ¾ of the allowed tension, per square inch upon that member; nor the pressure upon the bearing surface per square inch of the projected semi-intrados (diameter × thickness of piece) of the rivet or bolt hole exceed 12,000 pounds or one and a half times the allowed tension per square inch upon that member. In the case of field riveting the above limits of shearing strain and pressure shall be reduced one third part. Rivets must not be used in direct tension.

67. *Pins.*—Pins shall be so proportioned that the shearing strain shall not exceed 7,500 pounds per square inch for iron and 9,000 per square inch for steel; nor the crushing strain upon the projected area of the semi-intrados of any member connected to the pin be greater per square inch than 12,000 pounds for iron and 14,000 pounds for steel; nor the bending strain exceed 15,000 pound per square inch for iron and 20,000 per square inch for steel when the centers of bearings of the strained members are taken as the points of application of the strains.

68. *Bending Strains in Long Members.*—In case any member be subjected to a bending strain from its own weight or from local loadings, such as distributed floors on deck bridges, in addition to the strain produced by its position as a member of the structure, it must be proportioned to resist the combined strains.

69. *Plate Girders.*—Plate Girders shall be proportioned upon the supposition that the bending or chord strains are resisted entirely by the upper and lower

flanges and that the shearing or web strains are resisted entirely by the web plate; no part of the web plate shall be estimated as flange area.

70. *Webs of Plate Girders.*—The iron in the web plate shall not be subjected to a shearing strain greater than 4,000 pounds per square inch; and no web plate shall be less than three-eighths of an inch in thickness.

71. *Stiffeners.*—The web of plate girders must be stiffened at intervals, about the depth of the girders, whenever the shearing strain per square inch exceeds the strain allowed by the following formula:

$$\text{Allowed strain} = \frac{12{,}000}{1 + \frac{H^2}{3{,}000}}$$

When H = ratio of depth of web to its thickness.

72. *Thickness of Plates.*—No iron or steel plate shall be used less than ¾ inch thick, except for lining or filling vacant spaces.

The compression flanges of beams and girders must be stayed against transverse crippling when their length is more than 30 times their width.

The unsupported width of any plate subjected to compression must not exceed thirty times its thickness.

73. *Width of Flanges.*—The flange plates of all girders must be limited in width so as not to extend beyond the outer lines of rivets connecting them with the angles more than five inches or more than eight times the thickness of the first plate. When two or more plates are used on the flanges, they shall decrease in thickness outward from the angles.

74. *Reduction for Rivet Holes.*—In members subject to tensile strains full allowance shall be made for reduction of section by rivet holes, screw threads, etc.

75. *Camber.*—All spans shall be given a camber by making the panel lengths of the top chord longer than those of the bottom chord in the proportion of ⅛ of an inch to every ten feet.

76. *Angle Iron.*—The inner guard rails shall be let down over the ties, till the top of the 3" × 3" angle iron with which the upper inner angle is covered, shall be level with the top of the rail. The angle iron must be straightened, and the holes for the ⅞" screws with which it is to be fastened to the timber, must be slotted at the ends so as to provide for a temperature varying between 40° Fahrenheit, below zero, and 140° Fahrenheit above zero. Holes to be in each leg of the angle three feet apart in centre, and eighteen inches apart at each end. The guard rails must be bolted to every fourth tie with a ¾-inch bolt, so that heads of bolts on the inner guard will not be above the top of the angle iron.

77. *Quality of Tension Iron.*—All eye bars, rods, bolts and pins shall be made of a tough, ductile, fibrous iron uniform in quality, and which shall be capable of withstanding the following tests, when applied to full-sized sections of the material tested.

78. *Bar Iron.*—Round bars up to 1¼ inches in diameter must bend double, or until inner sides are in contact when cold, without showing signs of fracture.

Square bars must bend cold through 180 degrees around a cylinder having a diameter equal to two-thirds the length of side, without showing signs of fracture.

Flats must bend cold through 180 degrees around a cylinder having a diameter equal to the length of the shortest side, without sign of fracture.

The ultimate strength of the bar iron used shall not be less than $52{,}000 - \left(\frac{7{,}000 \times \text{area}}{\text{periphery}}\right)$ pounds per square inch; area and periphery being expressed in inches.

The elastic limit shall not be less than 26,000 pounds per square inch, and the elongation of the bar before rupture shall not be less than 20 per cent. in 12 diameters.

The reduction of area at breaking point shall not be less than 25 per cent. of the original section.

79. *Shape Iron.*—All plate and shape iron used in tension members, or in members exposed to both compressive and tensile strains, shall fulfill all the foregoing conditions when tested in specimens of one inch area and fifteen inches length of smallest section, except that the breaking strain per square inch shall not be less than 49,000 pounds for angles, 48,000 pounds for beams and channel iron, and 47,000 pounds for plate iron.

These classes of tension iron must bend cold, without fracture, as follows:

For Shape Iron	140 degrees
For Plate Iron	100 "

and the ductility must be

For Shape Iron	16 p. c.
For Plate iron	14 "

80. *Compression Iron.*—Wrought iron for compression members must be tough, fibrous, uniform in quality, and with an elastic limit of not less than 25,000 pounds per square inch.

Specimens of one square inch area shall bend through 90 degrees around a cylinder 1¼ inch in diameter without signs of fracture.

All cast-iron used shall be good, tough, grey iron, of such quality that a bar five feet long, one inch square, and four feet six inches between knife edge supports, will sustain a weight of 475 pounds on knife edge at middle of beam before breaking.

81. *Tension Steel.*—All steel used in tension shall have a minimum tenacity of 60,000 pounds per square inch, a ductility of 18 per cent. in 12 diameters, and test pieces 15 inches long and 1 inch in sectional area, cut either or both cross-wise or length-wise, of plate steel, and length-wise of bar or shape; after being heated to a low cherry red and cooled in water of 82 degrees of Fahrenheit, must stand bending double in a press or under the hammer to a curve of which the radius is one-and-a-half the length of the shortest side of the test piece. These test pieces may be cut in a planing machine and may have the sharp edges removed. Two samples shall be cut from each plate—one of which shall be tested for tenacity and ductility and the other for temper and bending, as above described.

Steel failing on both set of tests shall be rejected.

Steel up to the standard in tenacity and ductility but deficient in bending and temper test, shall be annealed after punching.

Steel up to the standard in all the tests need not be annealed.

82. *Compression Steel.*—All steel used in compression shall be of good quality of mild steel having a minimum tenacity of 65,000 pounds or over per square inch, an elastic limit of not less than 40,000 pounds, a ductility of 12 per cent. in 12 diameters, and not less than 15 per. cent. reduction of area at breaking point.

Specimens one square inch in area of section shall bend cold through 140 degrees around a cylinder, the diameter of which is four times the length of the shortest side of the test piece.

No steel shall be struck with a hammer or worked while at a black heat.

All steel, whether with drilled rivet-holes, or holes punched and reamed, shall be matched with the other parts of same member, and before being riveted up, all holes shall be matched and brought to a fit by reaming alone and without the use of drift-pins.

The matching of the holes shall be sufficiently close to permit the parts to be riveted up without producing an initial strain on the steel. Splice riveting in steel will be governed by the specifications for top chords and columns.

83. *Rolling.*—All tension iron shall be rolled from piles composed of piling pieces, each the full length of the pile. The use of old rails will not be allowed in the piles for this grade of iron.

All rolled iron or steel shall be thoroughly welded during the rolling and must be straight—of full section at all points—and free from injurious or unsightly seams, blisters, buckles, slivers, cinder spots and imperfect or crooked edges.

All material, as it comes from the mill must be first-class in every way; rolled pieces cut too close to the crop ends will not be accepted.

84. *Testing.*—All specimens for testing, cut out from large pieces, whether of iron or steel, shall have a uniform least section of one square inch not less than 15 inches long.

All bar and rod iron shall be tested in full sized sections whenever practicable.

No test specimen shall be hammered or forged after being cut out from the original piece.

Complete facilities for inspection of material and workmanship must be given by the contractor. Facilities and specimens for testing, and also the necessary labor, shall be furnished by him without charge when called for by the chief engineer or inspector. But when any full sized manufactured iron or steel members, are tested to destruction, and proved to be up to the standard required, such material shall be paid for at cost, less scrap value to the contractor.

Should such members fail to reach the standard, they will not be paid for, and the inspector may reject all similar members made of the same material.

The testing machine used by the contractor shall be compared with the U. S. Government machine at the Watertown Arsenal or the Kirkaldy machine in England, and, if the results vary, the difference shall be equated and added to or subtracted from the results obtained from the machine used by the contractor.

85. *Workmanship.*—All workmanship must be strictly first class, and not what is commonly termed "merchantable work." Finished pieces shall be true to size, section and line straight and out of wind at all points and all machine, hydraulic, rivet or smith work done, upon them shall be of the best character.

All measurements in laying out work shall be made with iron standards of the same temperature as the iron measured.

86. *Eye bars.*—All eye bars shall be either upset on the coiled bar, upset with piling piece, or rolled without welding. No patching at the forge fire will be allowed on bar or head. All heads shall be clean, full-sized forgings formed centrally on the bar in true line and "out of wind."

Bars of the same class, and belonging to the same panel shall be drilled at the same temperature.

Pin holes in the eye bars shall be bored to exact sizes and distances, and to a true perpendicular to the line of strain. The pin hole shall be in the middle of the head and in the centre line of the bar. No error in length of bar or diameter of pin hole exceeding $\frac{1}{32}$ of an inch will be allowed.

The section of metal opposite the centre of the pin hole, across the eye shall be proportioned according to the following table, the diameter of the bar being the unit.

PIN	BAR.	EYE SECTION.	
		Upset Heads or Weldless Bar.	Heads Rolled on Bars
0.67	1.0	1.50	1.33
0.75	1-0	1.50	1.33
1.00	1.0	1.50	1.50
1.25	1.0	1.60	1.50
1.33	1.0	1.70	1.60
1.50	1.0	1.85	1.67
1.75	1.0	2.00	1.67
2.00	1.0	2.20	1.75

For hammered eyes, the shape to be used will be determined by the chief engineer after the contract is awarded. No shape which on testing shows 5 per cent. breakages in the eye or neck will be accepted.

87. *Pins.*—Pins must be turned true to size and straight, no error of more than $\frac{1}{32}$ of an inch in diameter being allowed.

Pins connecting chords, posts and tie bars shall be fitted for pilot nuts, and shall not be more than $\frac{1}{32}$ of an inch less than the pin holes of the eye bars.

Pins connecting laterals with other members shall be turned down to a diameter of not more than $\frac{1}{16}$ of an inch less than the pin holes.

Pin holes in wing nuts, channel nuts or other arrangements for lateral connections, shall be drilled or else punched and reamed to a size not exceeding $\frac{1}{16}$ of an inch larger than the pin.

88. *Rods.*—Rods, round or square, used for ties or counters, shall be fabricated with the same precision and care as prescribed for eye bars.—They have loop-welded eyes with reamed intrados, the proportions of the loop to be approved by the chief engineer. Screw ends shall be upset so as to give 10 per cent. more sectional area at the bottom of the screw thread than in the body of the bar. Sleeve nuts, clevises, or other members used for adjustment, must have the pin holes, if any, drilled, and must be of sufficient strength to break the bar to which they are attached.

Rods, used for lateral or vertical bracing, may have pin holes $\frac{1}{16}$ of an inch larger than the pin, but otherwise are to be made with the same care as counter rods.

All eye bars and counter rods are to be tested to 18,000 pounds per square inch, and bars showing structural defects, permanent set, or too great extension under strain, shall be rejected.

89. *Columns and Top Chords.*—These shall be made of such iron or steel as is prescribed for members exposed to compression strain, except when otherwise specified. The splices shall be composed of edge-rolled plates in all cases. Abutting joints shall be milled off to exact lengths and square to the line of the chord. All pin holes shall be bored to an exact size, true to the line of strain, and correct as to position. No errors exceeding $\frac{1}{32}$ of an inch in length of part or in diameter or position of pin hole will be allowed. The pin holes may be bored $\frac{1}{32}$ of an inch larger than the pin, this is the utmost limit. Rivet holes in splices shall be punched $\frac{1}{16}$ of an inch less than required, and then reamed to fit. After the splice plates are riveted on in the shop, each line of chords or columns shall be assembled—the joints matched, their abutting joints brought to a tight fit by turnbuckles, and all rivet holes in the ends of chords and splices in which the rivets are to be field-driven shall be reamed to an exact match and fit. Match marks shall then be made on each piece.

Parts composing posts or tie struts must be in one length, without splices between end bearings, unless specially permitted by the chief engineer.

When necessary pin holes in posts, cords or tie struts shall be reinforced by additional material, which must contain rivets enough to transmit the strain to the original member. The open sides of posts, cords, struts and tie struts shall be connected by lattice or trellis bars, the angles of which shall not exceed 63° 25' for single bars, or 45° for double bars with riveted intersection.

The unsupported length of any lattice bar shall not exceed 45 times its thickness. All members of which the parts are connected by lattice or bracing bars shall have connection plates at each end, the row of rivets in which shall be equal to the width of the member in length, and not more than four rivet diameters in pitch.

In all compression members the connecting rivets within two diameters of the ends shall be pitched not to exceed four times the diameter of the rivet.

The several pieces forming any built member shall fit closely together, and the member shall be free from bends, twists and open joints.

90. *Riveted Work.*—All joints shall be square and truly dressed. Rivet holes shall be accurately spaced, and the rivets must be of the best quality of iron for the purpose, and when driven must completely fill the holes.

All rivets with crooked heads, or heads not formed centrally on the shank, or rivets which are loose, either

in the whole or under the shoulder, shall be cut out and replaced with good rivet.

Rivets holes shall not be spaced less than 2½ diameters between centers, nor more than 15 times the thickness of thinnest outside plate apart, 9 inches being the maximum pitch allowed in plate riveting.

No rivet hole shall be less than 1¾ diameters from the end of a plate, or 1¼ diameters from the side of a plate, nor ever less than 1¼ inches from center of hole to edge of plate except in cases where the plate or side of angle is less than 2½ inches.

The diameter of hole shall not exceed the diameter of the rivet more than $\frac{1}{16}$ of an inch.

When two or more thicknesses of plate are riveted together, the outer row of rivets shall, if practicable, not exceed three rivet diameters from the side edge of plate.

Where plates more than 12 inches wide are used in the compression flanges of girders or floor beams, an extra line of rivets, with a pitch of not over 9 inches, shall be driven along each edge to draw the plates together.

All joint rivet holes shall be so accurately spaced that rivets of the proper size can be passed through all the holes in the joint after the parts are placed in position, without the use of drift pins.

All splice plates in which the holes are mismatched, either in the plates themselves or with the adjoining chord or flange, shall be matched and the holes reamed to fit before leaving the shop.

No inaccurate or otherwise defective work will be accepted under any circumstances in connection joints of riveted work.

The riveted field connections of floor beams, stringers, posts and struts, must be accurately matched before leaving the shops, and all unmatched holes reamed to fit.

All rivets in splice or tension joints must be symmetrically arranged, so that each half of a tension member or plate, will have the same uncut area on each side of its center line. Whenever practicable, rivets must be machine driven.

91. *Pier Members.*—All bed plates must be of such dimensions, that the greatest pressure upon the masonry shall not exceed 200 pounds to the square inch. All spans shall have at one end nests of turned friction rollers, formed of wrought-iron or steel, running between planed surfaces. The rollers shall not be less than 2 inches diameter, and shall be so proportioned that the pressure per lineal inch of iron roller shall not exceed the product of the square root of the diameter of the roller in inches multiplied by 500 pounds, ($500 \sqrt{d}$). For steel rollers the pressure per lineal inch of roller shall not exceed the product of the square root of the diameter of the roller in inches multiplied by 600 pounds ($600 \sqrt{d}$). All the bed plates and bearings under fixed and roller ends must be fox-bolted to the masonry.

92. *Painting.*—All iron work before leaving the shop shall shall be thoroughly cleansed from all loose scale and rust, and be given one good coating of red lead paint mixed and applied as directed by the engineer.

In riveted work the surfaces coming in contact shall each be painted before being riveted together. Bottoms of bed-plates, bearing plates, and any parts which are not accessible for painting after erection shall have two coats of paint: the paint shall be a good quality of iron ore paint, subject to approval of chief engineer.

After the structure is erected, the iron work shall be thoroughly and evenly painted with two additional coats of paint, mixed with pure linseed oil, of such color as may be directed.

All turned and faced surfaces shall be coated with white lead and tallow before being shipped from the shop.

93. *Erection.*—The contractor shall furnish all staging and false work, shall erect and adjust all the iron work, and put in place all floor timbers, guards, etc., complete ready for the rails.

The contractor shall so conduct all his operations as not to interfere with the work of other contractors, or close any thoroughfare by land or water.

The contractor shall assume all risks of accidents to men or material prior to the acceptance of the finished structure by the railway company.

The contractor must also remove all false work, piling and other obstructions, or unsightly material produced by his operations.

FINAL TEST.

94. *Final Test.*—Before final acceptance, the chief engineer, may make a thorough test by passing over each structure the specified loads, or their equivalent, at a speed not exceeding 30 miles an hour, and bringing them to a stop at any point by means of the air or other breaks, or resting the maximum load upon the structure for 12 hours.

After such tests the structures must return to their original positions without showing any permanent change in any of their parts.

GENERAL.

95. *Change of Plans.*—It is to be understood that the chief engineer shall have power to raise or lower the grade line of both cuttings and embankments, and to change the height of the masonry piers as well as the trestle work, or to substitute trestle work for embankment or embankment for trestle work, or to make any other changes, if such may be found necessary or desirable, and that the contractor shall have no claim for extras on this account by reason of increased or diminished quantities. He shall simply be paid for all work done at the schedule rate.

96 *Power to Enter Upon Works.*—The company retains the right to enter upon the works at any time, and to carry on any work that may be considered necessary by the chief engineer, in order to erect the iron superstructure of the bridge or any other work that may be required by the company, and it is to be understood that this taking possession of the piers and abutments as they are ready for the superstructure or other portions of the work, is not to be considered a final acceptance of the work thus taken possession of.

97. *Damages to Adjoining Property.*—The contractor will be held responsible for any damage done by himself or parties in his employment to property adjoining the railway or bridge.

98. *Employees.*—The contractor shall employ mechanics for every species of mechanical work. No stone work of any quality shall be laid by other than regular masons who have served their time as such. The employees of the contractor shall at all times obey the directions of the engineer or his deputies with respect to the work; and if any overseer, agent or workman of the contractor shall be found unfaithful or incompetent by the engineer, or shall neglect or refuse to obey all reasonable orders of the engineer or his deputies, or shall have promoted disturbance upon the work, the contractor shall, on being required so to do by the chief engineer, at once discharge said person, and shall no longer employ him upon the work.

99. *Extra Work.*—No allowance will be made for extra work, except upon a written agreement signed by the contractor and the chief engineer, or under the written order of the chief engineer. All claims for extra work so ordered must be made to the chief engineer in writing before the payment of the next succeeding estimate after the work was performed, and failing to make such claim, the same shall be considered as abandoned by the contractor.

100. *Omission to Disapprove*—Any omission to disapprove of any work by the chief engineer at the time of a monthly or other estimate shall not be construed to be an acceptance of any defective work.

101. *Sub-letting.*—The contractor will not be permitted to sub-let any portion of this work without the consent of the company, and their approval of the sub-contractor; which consent or approval, however, shall by no means be considered a recognition of such sub-contractor. The contractor shall be bound at all times to have an office on the works, or in the City of Montreal, where by himself or some authorized agent, all notices or requisitions from the company or the chief engineer may be received and acknowledged.

102. *Estimates.*—Approximate estimates of work done and materials delivered shall be made on or about the first day of every month, and a valuation of the same in proportion to contract prices for the completed work will be made by the chief engineer, which sum shall be paid to the contractor, as nearly as practicable, on the tenth day of every month, less a deduction of 10 per cent. upon the said valuation, which 10 per cent. shall be retained till the final completion of the work.

103. *Stakes and Bench Marks.*—All grades, dimensions, etc., will be given by the proper stakes and bench-marks, such stakes and bench-marks must be preserved by the contractor until the prosecution of the work requires their removal. If the contractor, in a careless or wilfull manner, removes or causes the removal of any of said stakes or bench-marks before the prosecution of the work requires it, the expense of replacing them will be charged to the contractor, and the amount deducted from the amount due on his final estimate.

104. *Engineer to be Sole Judge of the Work.*—All works are to be done to the entire satisfaction of the chief engineer. He is to be the sole judge of work or material, in respect both of quality and quantity, and his decisions on all questions of dispute, with regard to the work or materials, or as to the meaning or interpretation of the plans or specifications is to be considered final and binding on all parties.

P. ALEX. PETERSON.
Chief Engineer.

MONTREAL, September 16, 1885.

YAZOO & MISSOURI VALLEY R. R.—Work is about to be commenced on this branch of the Illinois Central R. R. The line is divided into six residencies of about 11 miles each, making a total of 70 miles: The following are the resident engineers. 1st. resident, W. S. Carruthers, 2nd. M. Tobias, 3rd. R. W. Burn, 4th, J. W. Mercer, 5th, A. Clark, S. Lancaster. There are fifteen contractors, and the grading is to be completed by March. This will give the I. C. R. R. a 115 mile branch from Jackson, Miss. through Yazoo City to the Tallahatchee river. J. G. Mann is chief engineer; H. P. Farrar division engineer; and Capt. Martin right of way agent.

A New Explosive.

A new explosive, known as helloffite, which has been invented by Hellhoff and Gruson, has been subjected to comparative trials at St. Petersburg, together with nitro-glycerine and ordinary gunpowder. It is a solution of a nitrated organic combination (naphthaline, phenol, benzene, etc.), in fuming nitric acid. In preparing the helloffite tried in the experiments, binitro-benzine, a solid, inexplosive, and badly burning body, was used. At the first trial glass bottles of 20 cubic centimètres contents each were filled with 20 grammes of the respective explosive substances, and corked down. A tube filled with fulminate of mercury was passed through the corks, a slow match being attached to the outer end of the tube for the purpose of ignition. Each of the bottles thus prepared was placed on a truncated cone of lead, the upper diameter of which was 3.5 centimètres, its lower 4.5, and its height six. The cone itself stood on a cast-iron plate plate 2.5 centimètres thick. The deformation of the leaden cone by the action of the explosives could consequently be taken as a measure of their respective destructive power. The explosion of the gunpowder, as was anticipated, caused no changes. By the explosion of the nitro-glycerine the cone was compressed about a quarter of its height; its surface had assumed the appearance of a well-worn hammer; the diameter of the surface had been increased to 5.5 centimètres. The explosion of the helloffite caused much greater changes. The surface of the cone was completely torn; pieces five centimètres long and two centimètres thick were torn off and thrown about for several paces; only half of the cone was still a compact but entirely defaced mass. At the second experiment bottles (of 25 grammes each) filled with the various explosive substances were let into corresponding cavities bored into the face of fir blocks of similar dimensions. In exploding the gunpowder the block was torn into four pieces, as if split with a hatchet, the several pieces were thrown about for 18, 12, 11, and 10 paces. In exploding the nitro-glycerine the block was split into several pieces. The upper portion of the block, as far as the bottle was let into it, was torn off perpendicularly in the direction of the fibre in such a manner that a smooth cut was formed. The explosion of the helloffite likewise tore the portion of the block surrounding the bottle perpendicularly in the direction of the fibre, and splintered the remainder of the block into a large number of thin fibres. The following experiments were also made with helloffite alone: A slow match was passed through the tube in the cork which was without fulminate of mercury, as far as the surface of the helloffite in the glass bottle; no explosion followed on igniting the slow match. A quantity of helloffite poured into a bowl could not be exploded by a lighted match. Finally, a few drops of helloffite were poured on an anvil, and exposed to heavy blows with a hammer, and no explosion followed. The helloffite, consequently, possesses the following advantages: (1) In igniting it with fulminate of mercury it acts more powerfully than nitro-glycerine; (2) it may be stored and transported with perfect safety as regards concussion, as it cannot be exploded either by a blow or a shock, nor by an open flame. On the other hand, it has the following disadvantages: (1) Helloffite is a liquid; (2) the fuming nitric acid contained in helloffite is of such a volatile nature that it can be stored only in perfectly closed vessels; (3) helloffite is rendered completely inexplosive by being mixed with water, and can consequently not be employed for works under water.

ENGINEERING NEWS Three months for One Dollar..

Important Gunnery and Explosive Experiments at Lydd.

For several weeks past a series of very interesting and important experiments have been conducted at the new ranges at Lydd by the Experimental Department of the School of Gunnery, who have been assisted in their operations by batteries of the Royal Artillery from Dover and Portsmouth. The object of the experiments, which have been conducted under the supervision of well-known military experts, has been to ascertain the effect of artillery firing on earthworks, and the effect of the use of explosives of a much more powerful nature than has hitherto been used. The trials have been made on the Holmstone and Brooks ranges adjoining the camp. Owing to the dangerous character of some of the experiments, the camp commandant has issued, and will continue to do so whenever necessary—as other experiments of a similar character will be made before the season closes—notices, which are posted in the neighboring villages—warning the inhabitants.

The guns with which the experiments have been carried out up to the present time are as follows: 9.2 in. b. l. (20 tons); 6 in. b. l. (81 cwt.); 6.6 in. hydropneumatic carriage; 25 pr. and 40 pr.; 8 in. howitzer (70 cwt.); 6.6 in. howitzer (36 cwt.). The experiments may be summarised as follows: (1) Fire for destroying exposed earthworks and parapets from 8 in. howitzers and 6 in. b. l. guns; (2) fire directed against parallels and breaches from 5 in. b. l. guns; (3) high angle fire for the destruction of field magazines, etc.; (4) shrapnel fire at gun emplacements from 6.6 in. and 8 in. howitzers; (5) trials of high explosive es o u rsting charges, and the effect on earthworks with common shell fired from 9.2 in. guns; (6) the effect of quick firing b. l. guns in destroying explosives, etc., from 6 pr. Hotchkiss guns; (7) the protection necessary for field guns employed against operations of the attack; (8) the effect of firing against the force of earthworks liable to explode, from 6 in. guns and 8 in. howitzers; (9) the effect of shrapnel shell against sap heads.

The experiments have yielded very successful results, and some very valuable information has been obtained which it is calculated will be of great importance in future military operations. The exact nature and practical effect of the experiments are naturally very zealously guarded by the authorities. The most important series of experiments which have been conducted and which are now completed for the present season are those connected with the use of high explosives, but with regard to the results of these the authorities maintain the strictest possible reticence. The explosions, however, have been of such an extraordinary character that they have been distinctly audible for a distance of nearly twenty miles.

These experiments were conducted with nitro-glycerine, a large quantity of which was conveyed direct from the manufactories in Scotland to the Camp. Owing to the dangerous nature of the explosive, the railway companies refused to carry it, and it was conveyed by water and landed at Dungeness. The strictest precautions were taken in its conveyance from the shore to the camp. The transit was effected in carts, the material being carefully enveloped in no less than ten thicknesses of blankets. The effect of the experiments with this explosive was really astonishing. The primary object of the authorities is to obtain an explosive which will at the required time produce effects of a more destructive nature than has hitherto been obtained by ordinary shell-fire. Precautions are taken to prevent accident to those engaged in the operations.

During the experiments a few days ago one of the howitzer's burst with one of these charges, the breech of the gun being completely shattered. Those engaged in the operations were fortunately under shelter, the gun being fired by electricity. Both the gun and the carriage have been forwarded to Woolwich, where they will be carefully examined by experts. In addition to the nitro-glycerine experiments, tests have been made with a highly explosive substance of German manufacture. The explosive is composed of two ingredients, one of which is nitric acid, which is contained separately in glass receptacles, in which it is placed in the shell. In this condition they can be handled with impunity. The explosion takes place by means of a detonator after the shell has been fired, the two materials mixing when the glass receptacles are broken by the concussion. The result of the explosion is described as far more terrible than the nitro-glycerine. A series of torpedo experiments are shortly to be made on the coast near the camp, and it is stated will be of a very interesting character.—London *Mechanical World*.

The Wellesley, Mass., Water-Works.

The late report of F. L. Fuiler, C. E., of Boston and the engineer in charge, is so full in regard to the construction of these works, that we have reproduced his plans and made an abstract of his data as to cost, etc., for use in other proposed small water supplies.

Wellesley is a small town in Norfolk County, Mass. The first engineering work was commenced in the spring of 1883, by Mr. F. L. Fuller, C. E., of 7 Exchange Place, Boston; test wells are first driven at a number of points with the object of discovering a substratum of a gravelly nature with indications of a good supply of ground water. The first trials were unsuccessful, for though water was found, the soil containing it proved to be a fine quicksand; an excavation 16×10½ feet and 13½ feet deep was finally sunk not far from the Charles River, and a test with a Heald & Sisco centrifugal pump gave a roughly estimated yield of 100,000 gallons in 24 hours, though later measurements, with the ground drier, showed an average of 70,000 gallons in the same time.

In April, 1884, the Water Commissioners decided to locate a filter-well in the last-mentioned locality, about 400 feet from the Charles River and on the north west side of the brook leading from Longfellow's Pond. This filter well (see Fig. 1) was made by excavating to the depth of 20 feet, a pit 11 feet wide at the bottom, 12 feet at the top and 63 feet long; the sides were lined by a dry stone wall 5 feet thick at the bottom and 2½ feet at the top; the water enters this well through the sides and bottom. At the north end of the pit is the pump-well, 5 × 10 feet, made of 20-inch brick work and connected with the filter-well by a 20-inch gate. An 8-inch pipe, with gate, connects the pump-well with a spring about 900 feet distant. An 8-inch quarter-bend and a piece of 3-inch pipe reaching nearly to the bottom of the well forms the lower end of a syphon which when completed will furnish an additional supply to the pumping-engine. The small screen-well, 3 × 6 feet, at the south end of the filter is to admit water from the brook through an 8-inch pipe.

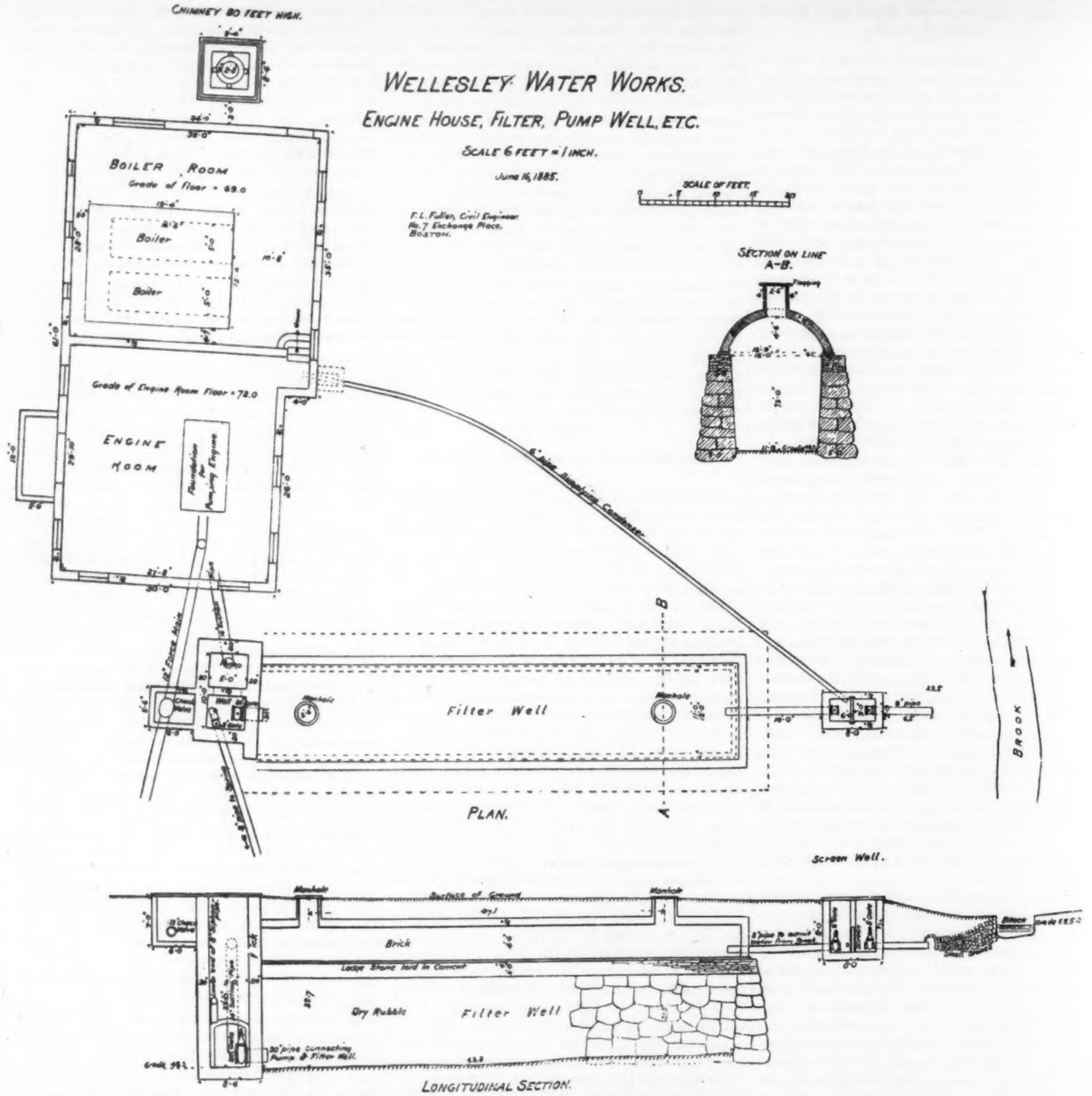
Tests made at the spring mentioned showed that its natural flow was 87,000 gallons in 24 hours, and by pumping from a pit 18 by 29 feet, excavated 6 feet into the gravel, 300,000 gallons per 24 hours were obtained.

The pumping station is a brick and freestone building with a chimney 80 feet high. Ten bids were received for its construction, ranging from $5,109.00 to $6,575.00; the lowest bidder was W. E. Scribner of Auburndale, and the contract was awarded to him. The pumping machinery consists of one compound condensing duplex engine built by the George F. Blake Man. Co. of Boston. The high pressure steam cylinder is 12 inches diameter; the low pressure cylinder, 22 inches; water plunger, 10 inches; stroke, 18 inches. It has an independent air-pump and condenser; each stroke displaces 5.89 gallons, and to pump one million gallons in 24 hours would require 117 strokes per minute, or a piston speed of 88 feet per minute. The boilers are two in number, horizontal, and were made by the Whittier Machine Co., Boston. Each boiler is 16 feet long, 60 inches in diameter, with 80 tubes 2¼ inches in diameter, 15 feet long. The heating surface, taken at the area of one-half the shell and the whole interior area of tubes, is 982 square feet. On the basis of 15 square feet of heating surface per horse-power, they are of 65.4 horse-power; at 22 square feet, each boiler has 44.6 horse power. This latter figure is the power required, under the conditions, to pump one million gallons in 24 hours.

The reservoir (see Fig. 2) is located on Maugus Hill, about 12,000 feet from the pumping station by way of the 12-inch main; this main traverses the main street of the straggling town in passing to the reservoir, the service being thus practically direct. The reservoir plan is so well shown in the illustration that little explanation is required; the concrete used in lining the inside slope is ten inches thick and was made of 2½ parts of broken stone or screened gravel to 1 part of cement mortar, made of 1 part F. O. Norton cement to 2 parts sand. Over this concrete is a 6-inch layer of broken stone and then the stone paving 12 inches thick. The concrete was used to make the banks water-tight, and the broken stone and paving to protect from frost and the wash of waves. On three sides of the reservoir the concrete is carried into the bank, as shown on sectional view. The bottom of the 6-inch layer of concrete is 4½ feet below high water, and it extends 10 feet into the bank to the face of the priming-wall, which latter was built of concrete on one side and on the other two sides of the reservoir of small stone laid in cement. The wall is plastered on the inside with ordinary cement and then received a wash of pure Portland cement applied with a brush. The filling above was well rammed by hand. This wall and concrete paving is thus well protected from frost, especially if the water in the reservoirs is kept well up to high-water mark, as it should be in cold weather. The bottom of the reservoir is covered with 6 inches of concrete sloping in all directions towards a 6-inch drain pipe.

As will be seen in the plan, the 12-inch force-main passes through the gate-house and discharges about 38 feet from the latter, where a one-eighth bend turns the current slightly upward. In the gate-house are two 12-in check-valves and one 12-in. gate, all connected with the 12-in. forcing main; and there are also two 6-inch gates connected with the drain-pipe. In operating these valves the water entering the reservoir forces open the one check-valve, but when there is no pressure towards the reservoir this check closes. At the same time that the pressure has been opening the first check-valve, it has kept the second-valve firmly closed, which second valve is connected to the force-main by a T just before reaching the first and is at right angles to it. The second valve only opens when the pressure is *from* the reservoir.

In the rear of the gate-chamber is an opening in the brickwork 18-inches square, which can be opened or closed by a sluice-gate moved by an iron rod and hand-wheel in the gate house; between this opening, through which all the water leaving the reservoir must pass, and the second check-valve are two sets of copper wire screens of No. 17 wire, ¼-inch mesh. There are four separate screens in each set, so arranged that they can be raised and cleaned. Three stay or cross-walls of masonry are built across the trench and around the pipe outside of the reservoir; these walls are some distance apart and serve



to intercept the water following down the pipe-line, which water is carried by drain pipes to the nearest gutter. The brick walls of the gate-chamber are 16-inches thick laid in cement; at the line of top of reservoir the walls are reduced to 12-inches that being their thickness in the gate-house.

All the cast-iron pipe in the distribution and force main was manufactured by A. H. McNeal, of Burlington, N. J. The lengths were as follows: 11,817 lineal ft., 12-inch; 7,601 ft., 10-inch; 4,530 feet, 8-inch; 35,599 feet, 6-inch, and 10,017 feet of 4-inch, or a total of 13.18 miles.

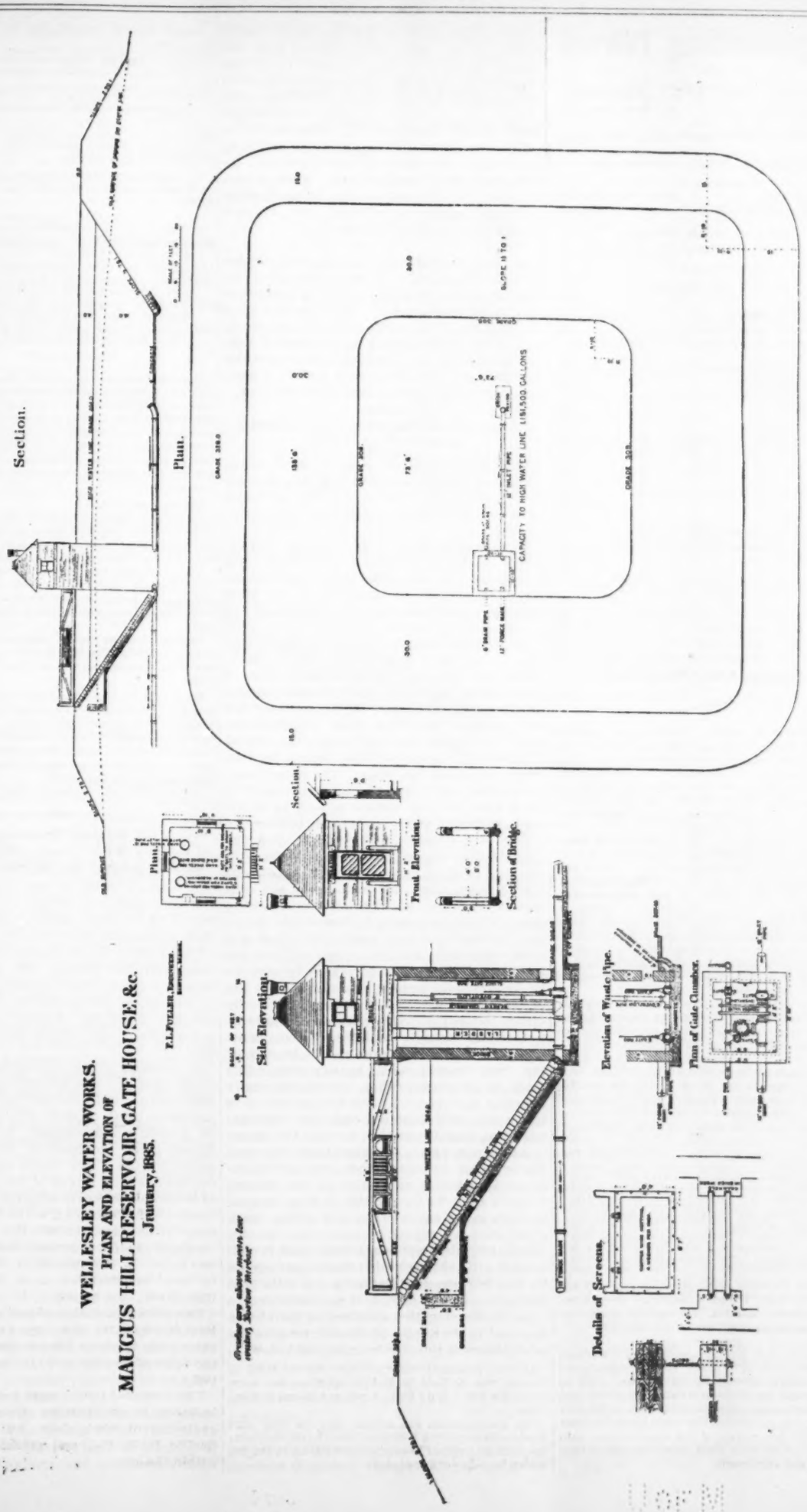
The pipe was of excellent quality, only four leaks being discovered on the total length in letting on the water and submitting the pipe to 200 pounds pressure per square inch, and only one leak was from a cracked pipe. The specifications required a tensile strength of 16,000 pounds per square inch; the test at the foundry showed that the iron considerably exceeded this requirement, the average of 68 specimens being about 22,604 pounds. The special castings came from the Builder's Iron Foundry, of Providence, R.I., and were also of excellent quality.

On May 20, 1884, 21 bids for laying and four for furnishing pipe were opened; the pipe-laying bids ranged from $16,465.00 to $52,507.00, and the bids for pipe varied from $58,250.11 to $65,282.00. The contract for pipe and the pipe-laying for 1,500 tons was awarded to John T. Langford, of Newton, Mass., at the following prices:

Cast-iron pipe per ton, gross tare.....	$36.00
Special castings.....	67.00
Laying 12-inch pipe, per lineal foot....	0.36
10-inch " " " "	0.30
8-inch " " " "	0.25
6-inch " " " "	0.20
4-inch " " " "	0.17

These prices include, according to the specifications, the setting of all gates, hydrants, special castings, bridge, brook and railroad crossings. The pipes were laid generally on the north side of streets running east and west and on the east side of those running north and south. On side streets, the pipe is laid generally 15 feet from the street line; on narrow streets, from 10 to 13 feet away. There is generally more sun on the north and east side of streets, and the frost does not go so deep. All pipes were laid with a covering of 5 feet to top of pipe. There are 1 20-inch gate, 7 12-inch, 4 10-inch, 7 8-inch, 41 6-inch and 15 4-inch; they are mostly of the Ludlow pattern, though some Chapman were used; both work well. There are in all 67 hydrants of the Ludlow pattern; four have four 2½ inch nozzles, the remainder have two 2½ inch nozzles. Most of them have a 4-inch inlet gate and a standpipe 5¾ inches diameter; the pressure on these hydrants, with full reservoir, ranges from about 64 to 120 pounds. The service pipe was tarred wrought-iron.

According to the Commissioners report appended, the actual total cost of the works has been within the appropriation of $125,000. Ten proposals were received for building the reservoir, ranging from $9,195 to 17,887. The contract was awarded to C. F. Dacey, of Nepponset, Mass., at the lower figure. The work was abandoned however after the second payment, and the reservoir was finished by day labor, there not being time to readvertise. The laying of service pipe and tapping the mains is done by contract at 20 cents per lineal foot for the pipe, and $1.00 for tapping the mains; all work done inside the cellar wall is paid for by the individual owner. The town charges the owner 25 cents per lineal foot from street-line to cellar wall.


WELLESLEY WATER WORKS.
PLAN AND ELEVATION OF
MAUGUS HILL RESERVOIR, GATE HOUSE, &c.
January, 1885.
F. J. Fuller, Engineer.
Section.
Plan.
CAPACITY TO HIGH WATER LINE 191,500 GALLONS
Section.
Plan.
Front Elevation.
Section of Bridge.
Side Elevation.
Elevation of Waste Pipe.
Plan of Gate Chamber.
Details of Screens.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

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CLUBBING ARRANGEMENTS.

1886.

The "subscription season" for the most popular American Magazines is close at hand, and inquiries as to our proposed clubbing arrangements are being made. We beg leave to announce, therefore, that on and after JANUARY 1, 1886, the subscription price of ENGINEERING NEWS will be **$5.00** per year; until that date the price and clubbing rates with other publications will remain as given below.

We are now planning such improvements in ENGINEERING NEWS, and negotiating for special work to be done during the coming year, as will cost double any possible increase of income from subscriptions; the long notice of change which we here given enables nearly, if not all, present subscribers to renew at present rates. We intend eventually to publish a class journal which will acknowledge no superior in the world, and we feel so confident of the support of our present patrons that we have no hesitation in venturing on the greatly increased expense necessary to carry out our programme.

If an English engineering journal, carrying fifty pages of advertisements and twenty four of reading matter sells for $10, why may not an American journal of equal merit sell for at least half as much.

In order to accommodate such of our subscribers as may wish to subscribe for other periodicals, we offer the following terms until January 1, 1886: We will send to any address ENGINEERING NEWS at regular subscription price, **$4.00** and the following at the additional prices given:

	Net. Price.	Reg. Price.
Atlantic Monthly	$3.25	$4.00
Century Magazine	3.55	4.00
Harper's Magazine	3.25	4.00
Harper's Weekly	3.25	4.00
Harper's Bazar	3.25	4.00
Harper's Young People (weekly)	1.65	2.00
Popular Science Monthly	4.25	5.00
St. Nicholas Magazine	2.55	3.00
North American Review	4.10	5.00
Cassell's Magazine of Art	m 3.00	3.50
Cassell's Family Magazine	m 1.25	1.50

The Century Magazine commences its year with the November Number; Harper's Magazine commences with the December Number. Subscribers should renew these Magazines in October and November.

Subscribers to other publications clubbed with ENGINEERING NEWS, must notify those "other publications" direct, of change of address during the year. After we have transmitted for the year's subscription and had the subscriber's name and address properly entered on the clubbing lists, our connection with the transaction *ceases entirely*. Our margin of five cents on each subscriber does not allow for much extra expense in time and postage and stationary.

THE description of the Wellesley Water-works, in this issue, is condensed from the official report of Frank L. Fuller, C. E., the engineer of the work. The original report is so unusually full and clear in its statements of work done, cost, etc., that we recommend it as a model. Although the town supply is comparatively small and the work simple in its design, every detail seems to have been intelligently and conscientiously worked out. It would be of much general value if other hydraulic engineers followed Mr. Fuller's example in recording what they do.

AT the regular monthly meeting of the Architectural Association of Minnesota held on September 8th, 1885, the following resolution was passed unanimously. That on and after the first day of January, A. D. 1886, the members of the Architectural Association of Minnesota abandon the system of measurement by feet and inches, and adopt a system of measurement by feet and decimal parts of a foot.

Civil Service Examination for a "District Surveyor" in Ireland.

The following outline of the range of knowledge and practice required to fill the position of a District Surveyor in Ireland, is taken from the advertising columns of a London journal.

If the examination is as thorough and extended as the line of questioning would seem to suggest, we fear that there would be an alarming number of vacancies to be filled were the county and district surveyors of our own country put to the same test.

The relative positions however of these surveyors, here and in England, differ greatly. Under the English system a wide range of professional knowledge and extensive practice are absolutely necessary in the applicant for the position; but with these requirements filled and the appointment made, the official is assured of a tenure of office lasting for life, unless removed for cause. The salary may be modest, varying with the importance of his district, but it is certain as long as he attends faithfully and strictly to his business.

This is a decided improvement upon our own practice, where the office is filled by popular vote at short intervals, or by appointment from a power that very seldom has any conception of the duties of the office. Like the filling of other positions in democratic America, the candidate may receive his office as a reward for services very far removed from the technical duties of a surveyor, or he may be the best man in the neighborhood and yet not be sufficiently schooled or trained to properly direct the engineering work of a county or a thriving district. Outside of our larger cities we have practically yet to learn that the best trained man, at any reasonable price, is far cheaper than the professionally ignorant man who, with the best intentions in the world, will blunder, and cost the taxpayers at some future time ten-fold the salary of a competent man, to correct these blunders. While we are well aware that civil service examinations are as unpopular in the country districts as in the large cities, it does seem to us that more engineering and better work could well be expended upon our country roads and public works generally, and if civil service will aid in selecting the proper agents for this improvement, let us have a little of it among our county engineers and surveyors.

As illustrating the standard of knowledge required in the applicant abroad, we give the advertisement referred to in full, as follows:

An open competition for a County Surveyorship in Ireland will be held in Dublin, in November next, under the Acts 7 and 8 Vict., c. 106, and 25 and 26 Vict., c. 106.

The Examination will extend over the four days commencing with 3rd November, and the six days commencing with 16th of November, and will be in the following branches of knowledge:

PART I.	Maximum of Marks.
Mathematics—including Geometry, Trigonometry, Algebra, Differential and Integral Calculus, and Geometrical Optics	100
Mechanical Philosophy—including Statics and Dynamics, Hydrostatics and Hydraulics, Pneumatics, and Heat regarded as a Source of Power	100
Experimental Science—including Inorganic Chemistry, Heat, Electricity, and Magnetism	100
Geology and Mineralogy	40

No Candidate will be eligible who does not show some proficiency under one at least of the heads included in Part I.

PART II.	Maximum of Marks
Strength and other Properties of Materials, and the Calculation of Strains	100
(A.) Railway and Canal Engineering	140
(B.) Marine Engineering—including Harbor, Dock, Sea, and Reclamation Works	140
(C.) Hydraulic Engineering—including Water Supply, Sewage, and Irrigation	140
(D.) County Works—including Architecture, Roads, Drainage, and River Works	140
	1000

Each of the groups lettered A., B., C., D., to include Designs, Estimates, Specifications, and the mechanical contrivances connected with it; and Candidates will be required to show that they have been engaged in the practice of their profession on adequate works for a sufficient time, or have had in some other way satisfactory opportunities of becoming acquainted with the practice of their profession in some one of the branches thus indicated.

Limits of age, 26 and 40.

Persons wishing to compete for this appointment, or to be reported qualified to act as Deputies to County Surveyors, must make written application to the Secretary, Civil Service Commission, London, S. W.

No person will be admitted to compete from whom the Secretary, Civil Service Commission, has not received, on or before the 23rd October, an application on a prescribed form, which may be obtained from him at once.

Such inquiries as may be necessary will be made by the Civil Service Commissioners, with regard to the age of Candidates, and also as to their health and character.

NOTE.—All the Candidates who reach the prescribed standard, and furnish the required proof of age, health, character, and professional training, will, if they so desire it, be certified. One of them will be appointed County Surveyor, and the others will be eligible to act temporarily as Deputies, but will have no claim to be appointed County Surveyors.

Dublin Castle, 16th September, 1885.

St. Paul, Minnesota.

The remarkable growth of some, at least, of our Western cities is well illustrated in the statistics gathered by the Chamber of Commerce, of St. Paul, Minn., and published in their late annual report for 1884.

The building record shows that in the four years, 1881, 1882, 1883 and 1884, 9,632 new buildings were erected, at a valuation of $32,176,107; in 1884 alone the record is 2,383 buildings, valued at $7,266,477. Among these structures is the Hotel Ryan, costing completed, $1,000,000.

In estimating the population, there is no doubt that the commercial authorities have mustered about all the individual souls that a justifiable pride in their city, and interest in its growth could suggest. But though the figures given are from an avowed estimate, and not from a per capita enumeration, we can assume their return of 125,000 inhabitants as being somewhere nearly right. This return is astonishing enough if we look at the strides made by decades. In 1850, the population, according to the U. S. census, was 840; in 1860, it was 10,500; in 1870, 20,300; in 1880, 41,498; and by local enumeration since, in 1881, 50,900; 1882, 75,835; 1883, 106,053.

The official valuation of real property in St. Paul is $60,463,163, based upon one-half of real value; this is about 100 per cent. increase on the value of real property in the same city in 1881.

The proposed public work for the year 1885, included an expenditure of nearly $3,000,000, exclusive of work done by the Northern Pacific R. R. Co., and private corporations within the city.

Annual Report of the Boston Water Board.

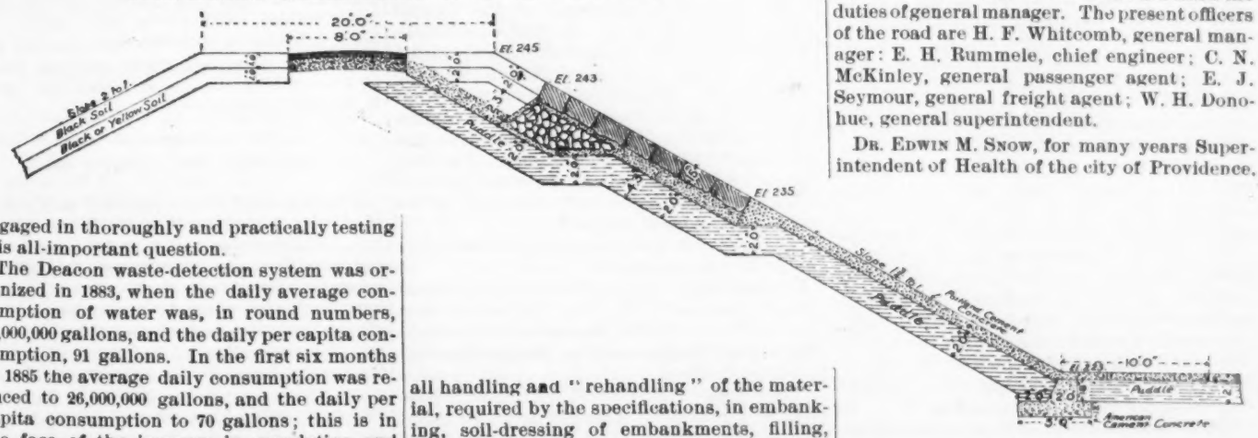
The ninth annual report of the Boston Water Board covers the year ending April 30, 1885. The provisions for the prevention of waste of water are of perhaps the greatest general interest, the city of Boston being now engaged in thoroughly and practically testing this all-important question.

GENERAL STATISTICS.—BOSTON WATER WORKS

SUDBURY AND COCHITUATE WORKS.	1882.	1883.	1884.
Daily average consumption in gallons	31,970,800	32,836,900	25,090,500
Daily average consumption in gallons per inhabitant	91	91	68
Daily average amount used through meters, gallons	4,387,530	5,085,600	5,171,126
Percentage of total consumption metered	13.7	15.5	20.6
Number of services	48,160	49,290	50,632
Number of meters and motors	2,463	2,919	4,666
Length of supply and distributing mains, in miles	367.2	378.0	388.5
Number of fire-hydrants in use	4,320	4,446	4,573
Yearly revenue from water-rates	$1,127,992.32	$1,167,704.17	$1,203,192.55
Yearly revenue from metered water	$319,785.42	$371,074.61	$378,484.75
Percentage of total revenue from metered water	28.4	31.8	31.5
Cost of works on May 1, 1883, 1884 and 1885	$17,184,751.14	$17, 75,955.68	$18,173,644.45
Yearly expense of maintenance	$249,064.71	$300,851.34	$336,578.36
MYSTIC WORKS.			
Daily average consumption in gallons	6,574,400	7,093,500	6,209,700
Daily average consumption in gallons per inhabitant	77.0	82.5	71.0
Daily average amount used through meters, gallons	800,830	933,150	969,246
Percentage of total consumption metered	21.2	13.1	14.0
Number of services	13,992	14,453	14,939
Number of meters and motors	405	501	571
Length of supply and distributing mains, in miles	146.0	147.2	[1]129.2
Number of fire-hydrants in use	748	770	794
Yearly revenue from water-rates	$245,981.85	$259,791.28	$262,248.50
Yearly revenue from metered water	58,459.80	$68,116.91	$63,627.39
Percentage of total revenue from metered water	23.8	26.2	24.3
Cost of works on May 1, 1883, 1884, and 1885	$1,641,762.22	$1,648,452.35	$1,656,266.70
Yearly expense of maintenance	84,483.87	$116,572.94	$128 126.40

[1]Reduction caused by correction of errors in previous reports.

CROSS-SECTION OF EMBANKMENT. FISHER HILL RESERVOIR.



The above table gives, in a compact shape, a summary of the results obtained in the three years covered by the return.

The quality of the water during the past year has been reported as excellent, though investigation is still being carried on in the pollution of the supply in Natick, Framingham and elsewhere.

At the Mystic Pumping Station, with a total quantity of 2,310,709,400 gallons pumped, the cost per million gallons lifted one foot high was $0.067. The report contains the results of an exhaustive trial made at this station to test the efficiency of the boilers.

The Deacon waste-detection system was organized in 1883, when the daily average consumption of water was, in round numbers, 32,000,000 gallons, and the daily per capita consumption, 91 gallons. In the first six months of 1885 the average daily consumption was reduced to 26,000,000 gallons, and the daily per capita consumption to 70 gallons; this is in the face of the increase in population and manufacture and a defective distribution system in Somerville and Chelsea. The precentage of reduction from the year 1883 was, for the Sudbury and Cochituate supply, 23.6, and for the Mystic, 9 per cent.

The Fisher Hill Reservoir, Boston Water-Works.

The vagaries of judgment among contractors and the various methods of interpreting the true meaning and intent of a specification are pretty well illustrated in the detail of bids—published elsewhere in this issue—for the building of the proposed reservoir at Fisher's Hill, near Boston, Mass.

According to the specifications and plans this reservoir is to be 500 by 295 feet at the water-line when full, to have a capacity of about 15,000,000 gallons, and to contain a stone gate-chamber. The cut shows a section of the embankment, slopes, etc. The interior slope is covered with 2 feet of puddle protected by 9 inches of concrete, broken stone and slope paving as shown. The walk on top of the bank is of coal-tar concrete.

The item of "Earth Excavation" includes all handling and "rehandling" of the material, required by the specifications, in embanking, soil-dressing of embankments, filling, grading, etc.; provided only that "soil rehandled for covering portions of the grounds that have been graded outside of the location of the embankment will be again paid for as earth excavation, and earth used in the puddle and stone used in the ballast will be again paid for as puddle and ballast." The earth excavation price also includes the cost "of clearing the grounds, pumping, ditching, bailing, sheeting, bracing, rolling, ramming, and all other incidental work."

As will be seen, this item of "earth excavation" is rather a comprehensive one, and it is not very remarkable after all, that the contractors should vary in their estimate of cost. Any approximately correct estimate, even, would require a very thorough study of the ground and specifications and the most economical method of work.

The puddle is assumed to be one-third pure clay on the slopes and one-sixth pure clay on the bottom, the remainder being material found in the reservoir. The bottom puddle is applied in layers of 3 and 4 inches according to material used; it must be thoroughly mixed and pulverized, either by hand or by such implements as the engineer may select, the cost of such implement not to exceed $100, and to be paid by the contractor. The slope puddle is put on in 6-inch layers and rammed, and all cracks in the puddle are to be repaired by the contractor.

The stone-ballast, shown back of the slope paving, will generally not exceed 2½ inches in greatest diameter, though in the upper or thicker portion unbroken boulders, not exceeding 12-inches in any diameter, may be used, provided they do not come within 3-inches of the puddle, earth, or paving.

The slope-paving is straight-faced quarry-stone, with a face area of not less than 3 square feet, and stones well fitted together with but very few pinners, the average depth of paving is to be 15 inches.

The requirements for cement, sand and mortar, and concrete, and brick and stone masonry are those usually found when first-class work is called for.

PERSONAL.

THOMAS W. PIERCE of Boston, President of Galveston, Harrisburg & San Antonio Railroad, died of apoplexy, Oct. 2, at Clifton Springs, N. Y. He leaves an estate valued at $10,000,000.

E. B. THOMAS the new general manager of the Richmond and Danville system, will enter upon the discharge of the duties of the position, the 15th of this month.

THEODORE VOORHEES, of Ballston Spa., N. Y. Superintendent of the Delaware and Hudson Canal Company, has been appointed Assistant General Manager of the New York Central Railroad.

H. G. H. REED'S resignation as general superintendent of the Lake Shore and Western took effect Oct. 1, and H. F. Whitcomb assumed the duties of general manager. The present officers of the road are H. F. Whitcomb, general manager: E. H. Rummele, chief engineer; C. N. McKinley, general passenger agent; E. J. Seymour, general freight agent; W. H. Donohue, general superintendent.

DR. EDWIN M. SNOW, for many years Superintendent of Health of the city of Providence, has been invited by the city officials of Montreal to take charge of the small-pox epidemic in that city. He has been tendered the absolute control of the sanitary department of the city for a period of three months. The Providence *Journal* says he has accepted the invitation conditionally.

SELMAR SIEBERT one of the foremost map engravers of the present day, died recently on his return from Europe to this country, and was buried at sea. He was as favorably known in the United States as in Germany, many of our government maps, as well as the best maps of the Prussian general staff, having been engraved by him. In spite of his advanced years—he was 78 years at the time of his death—Siebert was unusually active, and traveled frequently from Washington to Berlin. He had just received another commission from the Prussian government.

WILMON W. C. SITES died at his residence, on Bergen avenue, near Duncan avenue, Jersey City, Oct. 1. He was one of the best known civil engineers in New Jersey. He was born in Philadelphia 35 years ago, and was for some years a railroad engineer. In 1880 he was made Chief Engineer of the Jersey City Board of Works, but a year ago resigned to become Engineer for the State Board of Assessors. It was he who valued the property of the railroads for taxation under the new railroad tax law. Mr. Sites was elected a member of the American Society of Civil Engineers on Nov. 6, 1878.

DIED, at Providence, R. I., 2nd inst., EMILIE T., wife of E. L. CORTHELL, C. E., of this city.

WILLIAM HOOD has been appointed Chief Engineer of the Southern Pacific Company, Pacific system.

MR. MATT TAYLOR, of the Granolithic Paving Co., has added to his already multitudinous duties and business responsibilities by assuming the presidency of the Star Roofing Co., the sole agents of the long and favorably known Sparham Fire-proof Roofing Cement in the States of New York, Pennsylvania and New-Jersey. The office of the company is at No. 15 State St., New York City.

A CHICAGO journal publishes the following personal item:

"J. A. LATCHA, of Toledo, receiver of the Michigan & Ohio Railroad, has been appointed consulting engineer of the great Croton Aqueduct, New York."

On enquiry at the office of the Croton Aqueduct Commission, in this city, we find that the gentleman referred to is unknown, even by name. There is a mistake somewhere; it must be some other aqueduct.

DR. THOMAS C. DURANT, died at his home in North Creek, Warren Co., N. Y., on October 5. Mr. Durant was born in 1820 at Lee, Berkshire Co., Mass. He graduated from the Albany Medical College in 1840, but after practicing 3 years he became a partner in the shipping firm of Durant, Lathrop & Co., of Albany, N. Y. In the course of his very extensive business operations, Dr. Durant became earnestly interested in internal improvements and an advocate of railways. He assisted materially in promoting the interests of the Michigan Southern R. R., and was principal contractor in building the Chicago & Rock Island and the Miss. & Missouri railroads. From 1863, Dr. Durant engaged in the Union Pacific railway enterprise, making preliminary surveys at his own expense, from Omaha to the Great Salt Lake, and investigating the mineral resources of the country. In 1864, he perfected the financial organization under which the Union Pacific was carried to completion. Since the completion of the Union Pacific, and to the time of his death, he was the principal owner and general manager of the Adirondack R. R.

Mr. Durant pushed the work on the Union Pacific R. R., with his characteristic energy. Returning from Europe in the fall of 1867, he found the construction tied up at Sydney for the season, but realizing the necessity of a speedy completion of the road, he pushed it on to Dale Creek Bridge, 135 miles further west. During the winter he accumulated material and perfected his organization, to such good purpose, that within one year and twenty days from the time of starting in the next spring, he had laid 535 miles of track through and across the Rocky and the Wahsatch Mountains, and joined his road to the Central Pacific In this remarkable railroad work he was ably seconded by the untiring energy of Samuel B. Reed, the Superintendent and Chief Engineer of Construction.

MAJOR ZENAS C. PRIEST, Superintendent of the Middle Division of the New York Central and Hudson River Railroad, will on Oct. 18, complete 50 years of service with that corporation. Recently the directors caused a minute to be entered upon their records, stating this fact and also saying: "During the whole of that period, in every position he has occupied, he has merited and received the full confidence of the company. Springing from the ranks and promoted, steadily to higher trusts, his work and life illustrate the value and appreciation which belong to and attend duty always faithful and conscientiously performed. He has become in this half century a part of the company which from small beginnings now traverses the State from the sea to the lakes, and by its connections crosses the continent. The Directors desire to mark the termination of Major Priest's 50 years with the New York Central by an entry upon the records which shall preserve and perpetuate the event, and as a body and individually extend to him their cordial congratulations upon his hale and vigorous 80 years, and best wishes for many more years of health, happiness, and usefulness.

American Society of Civil Engineers.

At the meeting of the Society held October 7, the following was in brief the business transacted:—The Secretary announced the appointment of Mr. L. G. F. Bouscaren, Mr. Robert Moore and Mr. W. Howard White, as a board of censors to award the Norman Medal; the board to award the Rowland prize, will be Mr. Mendes Cohen, Mr. E. P. North and the Secretary of the Society. The deaths of Wilmon W. C. Sites, Member, and Thomas C. Durant, Fellow of the Society were announced. The members of the Society adopted by letter ballot a resolution, presented at the Deer Park Convention, appointing a committee of five members to consider and report to the Society on the proper relation which the form of the head of a rail should bear to the section of a car-wheel tread and flange.

The paper of the evening was read by Mr. Edward Bates Dorsey, it being a supplement to his paper on "English and American Railroads Compared," presented at the Annual Convention of June 24. In this supplement Mr. Dorsey compared in detail the operating expenses of the systems of England and the United States. In point of traffic it seems that the American railroads average more than double freight, and only eleven per cent. less passenger traffic than the English. The Boston and Albany R. R. is shown to have a larger passenger and freight traffic than any of the large trunk lines of England

The following gentlemen were declared elected to the classes named.

FOR MEMBERS:—*William Price Craighill*, Lieut-Col. of Engineers, U. S. A., Baltimore, Md.; *Hiram Stevens Maxim*, Managing Director and Mechanical Engineer of the Maxim Gun Co., London, England

FOR JUNIORS:—*Bernard Frank Booker*, Brooklyn, N. Y.; formerly engaged upon Atchison, Topeka and Santa Fé R. R., and recently Division Engineer, Tampico Branch, Mexican Central R. R.; *Thomas John Brereton*, Maintenance of Way Department Pennsylvania R. R., Altoona, Pa.; *Joseph Maxwell Carrere*, New York Steam Co., New York; recently engaged upon Burlington and Missouri River R. R.; *Charles P. Matlack*, City Engineer, San Antonio, Texas; formerly engaged with Keystone Bridge Company; on United Pipe Lines, Bradford, Pa., on International and Great Northern Railroad, Texas; on Mexican National Railroad.

Sewage Disposal.

Mr. Thomas Dart, of Buffalo, sends us a description of his patent on a method of rendering sewage available for fertilizing purposes, the salient points of which are as follows: two culverts, which are used alternately, are fitted with filter beds to retain the sludge, the liquid flowing away to a river or stream; this sludge is conveyed by machinery into covered tanks containing fresh quick lime which being slacked by the moist sludge acts as a deodorizer, so that the sewage may be carted from the tanks to be used as a fertilizer, It is claimed that the operations are carried out without nuisance of any kind. Further particulars may be obtained of Mr. Dart, at 458 North Division street, Buffalo, N. Y.

ENGINEERING NEWS, Three Months, for One Dollar.

A New Pavement.

The "*Sanitary World*" describes a new pavement introduced by the Grano-Metallic Stone Company, of London.

The composition consists of crushed blast-furnace slag and ground granite in certain proportions, chemically treated. When a certain degree of consistency has been attained by mixing with an alkaline solution and Portland cement, the mass is ready for laying, either in a plastic condition *in situ* or in blocks of 10 feet by 7 feet, on a rough ballast. For pavements a thickness of from 2 to 3 inches is used, while roadways are somewhat deeper. The material is ready for traffic in less than twelve hours after laying. Being laid in a plastic state and mixed on the spot, there is no occasion to block a whole footpath or roadway as is done with wood or asphalte pavement; this will be appreciated where there is heavy traffic, as will also the fact that it never becomes slippery by wearing, which is due to the hard vitrified atoms of blast-furnace slag always presenting themselves above and beyond their associated materials. Grano-metallic stone is exceedingly durable, and fire-proof as well as waterproof. The inventor claims that it will bear a greater pressure than any other artificial stone, having in fact withstood a pressure of twenty tons per square inch. The stone hardens under water, and for this reason could be used for docks, and basements, etc., while it is adapted for the flooring of stables, cattle sheds, and barns. It is being introduced into London, and has been adopted by some important railroad companies for paving stables and stations. Mr. J. H. Bryant is the inventor.

Trials of a New Elswick Gun.

A trial has just been concluded at Woolwich of a new breech-loading steel-rifle Elswick gun. The weapon is a 6-inch 100-pounder gun weighing five tons. The breech-closing mechanism is different from the Woolwich gun, having a double interrupted screw instead of a single one, the object sought being greater strength and the prevention of liability to jamming. On the gun being fired a second time the vent piece, which carries the primer or tube and firing apparatus, blew out and was projected a distance of 200 yards. It was recovered unimpaired, and seven more rounds were fired from the gun. Such an accident, the Woolwich artillerists say, could not have occurred with the Woolwich gun. Recently, however, in firing the Woolwich gun, the vent axial became cracked or jammed. This happened when firing the 43-ton Woolwich gun with 265 pounds of black powder, which is stated to be much more violent in action than its ordinary charge of 295 pounds of brown or cocoa powder. The damage to the Woolwich gun was at once repaired, and the experiments with it were resumed at the government butts. With regard to the Elswick Ordnance Company's gun, the breech mechanism is more complicated than that of the Woolwich gun, inasmuch as it has the vent piece going through the breech screw, which has to be taken out each time it is fired for the tube to be refixed. Whether the new arrangement will prove stronger than the vent axial of the Woolwich gun, further experiments will have to decide.—*Iron.*

A Forty-Five Tons Cylinder Gaol.

The new gaol just completed costs $30,000. Its peculiar feature is that the cells are arranged in the form of a great iron cylinder, which revolves about so that only one cell is at the opening at any one time. This cylinder is three stories high, there being ten cells on each floor. Its weight is 45 tons, and this ponderous weight is hung from above instead

of turning on a track below. The strangest part of the arrangement is that the great cylinder can be turned by a simple crank with very little force, a man with his left hand moving it readily. When all is complete it is the intention to have a little water motor in the basement, and then by simply moving a lever the cylinder will be set to rotating. It is suggested that when there are prisoners who, it is feared, may be trying to cut out the cylinder, can by a motor be easily kept moving slowly all night, so that the prisoners do not remain long enough in one place to do any mischief, or even to crawl out if they had made a partial break. It seems that prisoners have little chance for escape from this new gaol. A cage of iron bars completely surrounds the cylinder in which the cells are. The entrance on each floor is guarded by two doors. The officer standing outside does not have to unlock even the first door, but can swing the cylinder around until the cell appears in which is the desired prisoner, and then by a simple movement the inner door is opened and the prisoner can step out of his cell. Then the officer can open the other door and let the man out, but the other prisoners are way beyond any possible reach of the officer, and it is impossible for them to make any break on him while he is taking a man out or putting one in. He can handle any number of men in the same way, and they cannot get within reach of him until he chooses to let them.—*Omaha Bee.*

Maximum Wind Pressure.

During the hearing by the Parliamentary Committee of the case for the promoters of the Tower Bridge over the Thames, Mr. B. Baker, who was called to prove the stability of the proposed structure, gave evidence upon the phenomena of wind pressure as observed by him in connection with the construction of the Fortn Bridge. Mr. Baker stated that, from recorded observations in the Firth of Forth extending over many years, he has come to the conclusion that no pressure at all approaching 56 pounds per square foot can prevail over a surface of any magnitude. He declared that no such pressure has for many years occurred in the Thames Valley, instancing, in proof of this assertion, the number of large gasholders scattered up and down the river side. If a hurricane of 56 pounds to the square foot had encountered any of these structures, Mr. Baker believes they would have been doubled up and blown across London, as they have no power of resistance to external pressures beyond the pressure of the gas from within, which he values at not more than 18 pounds per square foot. If, therefore, not the slighest damage of this kind has ever be done by wind to any of the London gasholders, which is a fact, it is a demonstration that they have never been exposed to a pressure of 56 pounds per foot. It is Mr. Baker's experience at the Forth Bridge works that a gale registering by his improved instruments not more than 16½ pounds per square foot completely stops all ordinary traffic on the estuary, preventing the running even of powerful ferry-boats. Mr. Baker believes that this pressure is rarely exceeded. He declines to place credit in ordinary anemometer readings, which sometimes show extreme velocities, and he points out that trains do not cease running in gales when anemometers will register 46 pounds pressure to the foot, though a pressure of 40 pounds of wind per square foot on its exposed side would certainly upset an ordinary train.

THE Carolina Central railroad has begun the work of extending its line to Rutherfordton, N. C., and thence to the famous Cranberry iron mines.

The Forth Bridge.*

BY MR. B. BAKER, M. I. C. E., LONDON.

The North British Railway Company for many years have striven hard to obtain a physical connection of their lines north and south of the Forth by means of a bridge. Twenty years ago they were authorized by Act of Parliament to build a bridge across the Forth at a point five miles above the site of that now under construction, but borings 120 feet in depth showed nothing but soft silt and mud, and the bridge, which was to have been two miles in length, inclusive of four spans of 500 feet each, was luckily abandoned, as the difficulties with the foundations would have proved practically insuperable. In 1873 another Act was passed for a bridge across a narrower and deeper part of the Forth at the Queensferry. At low water the width of the channel there is about 4,000 feet, and the island of Inchgarvie affording a foundation for a central pier, it was possible to cross the 200 feet deep portion of the seaway by a couple of spans from 1,600 feet to 1,700 feet each in the clear. Sir Thomas Bouch prepared a design for this bridge on the suspension principle, with towers 665 feet in height from base to summit, and the contract for its construction was let to Mr. Arrol. Owing to the subsequent fall of the Tay Bridge, public confidence in Sir Thomas Bouch's design was shaken, and in session 1881 a Bill for the abandonement of the Forth Bridge was proceeded with. Whilst in committee, the different companies interested, namely, the North British, Great Northern, North-Eastern, and Midland Railway Companies, ordered a final reference of the whole question to their respective consulting engineers, with the result that the abandonment Bill was dropped, and the design for the cantilever or continuous girder bridge prepared by Mr. Fowler and myself, in consultation with Mr. Harrison and Mr. Barlow, was submitted for the original suspension bridge. In 1882 the necessary Parliamentary powers were obtained, and in January 1883, the works were commenced by Messrs. Tancred, Arrol, and Co., the contractors.

The total length of viaduct included in the contract sum of £1,600,000. is about 1½ miles, and there are

2	spans of	1710	feet	each
2	"	675	"	"
15	"	168	"	"
5	"	25	"	"

Including piers, there is thus one mile of main spans, and half a mile of viaduct approach. The clear headway is 150 feet above high water and the tops of the great cantilevers are more than 200 feet higher still. There will be about 45,000 tons of steel in the superstructure of the bridge. and 120,000 cubic yards of masonry in the piers.

Piers.—The South Queensferry main pier consists of a group of four cylindrical piers of masonry and concrete, founded by means of pneumatic caissons on the strong boulder clay constituting the bed of the Forth at this point. Owing to the slope of the clay, the caissons required to be sunk to depths varying from about 70 feet to 90 feet below high water. The diameter ranges from 70 feet at the base to 60 feet at low water level, above which the iron skin of the caisson is replaced by a facing of Aberdeen granite. At the base of the caissons is a working chamber 7 feet in height, supplied with compressed air, and electrically lighted, for the men excavating the material. This chamber was kept clear of water by a pressure of air considerably less, as a rule, than that due to the head of water outside. For example, at 90 feet below high water, when the north-east caisson had been sunk through a considerable thickness of silt, the air-pressure required to be maintained at 18 pound per square inch only, although at the reduced depth of 57 feet it was found convenient to work at 30-pound air pressure. Three shafts and air locks were provided for each caisson, two for the excavated material, and one for the men. The former had two horizontal sliding doors actuated by small hydraulic rams, and the skip containing the clay and boulders was hoisted up the 90-foot shaft by a steam engine mounted on the side of the air lock. As a rule, from 200 to 300 skips of excavated material were raised per day of 24 hours by a force of from 20 to 30 men. The maximum number of skip loads was 363, and of men 33. The size of the skips was 3 feet in diameter by 4 fee 3 inches high. Owing to the extreme hardness of the clay it was necessary to provide a certain number of spades having hydraulic rams in the handles, which abutting against the roof of the working chamber, sliced the clay readily.

At the present time three of the South Queensferry caissons have been sunk successfully to the full depth, and the fourth and last would also have been completed but for an unfortunate accident which happened to it at the beginning of the year. By some means the caisson, which had been floated into position for some weeks, accidentally filled with water, and sank and slid forward on the mud. It is now being carefully cased in timber to admit of the water being pumped out and the caisson floated again into position.

At Inchgarvie similar pneumatic caissons are used for two out of the four cylindrical piers, and the work on both is in full progress. Owing to the slope of the rock bottom, it is necessary to cut away as much as 18 feet in thickness of whinstone rock to form a level bench for the pier at 70 feet below high water, and the most convenient way of doing this was to convert the base of the pier practically into a great diving bell 70 feet in diameter. In this case, there being no silt over the rock, the pressure of air necessarily is that due to the depth of water outside, and somewhat sensational "blows" occur with a falling tide. Rock drills are provided, and blasting goes on in the compressed air chamber without necessitating the withdrawal of the men.

At North Queensferry, the four main piers were built either on dry land or within timber and clay cofferdams. Above low water the whole of the main piers are built of Arbroath masonry in cement, faced with Aberdeen granite, and hooped occasionally with 18 inch wrought-iron bands. The cantilever end piers, and the viaduct piers, are built of rubble, concrete, and granite in cement.

Superstructure.—Although the piers of the Forth Bridge present many points of interest, it is the enormous span and novel design of the superstructure that has attracted the attention of the engineers of the world to the work now in progress at Queensferry. The chief desiderata in the biggest railway bridge ever proposed to be constructed are durability, strength, and rigidity under express trains and hurricane pressure; facility and security of erection, high quality of material and workmanship, and economy in first cost and maintenance. These, we considered, would be best met by a steel "cantilever" or "continuous girder" bridge. Since the commencement of the Forth Bridge, American engineers, ever bold and ready, have built three cantilever bridges of considerable spans, and practical experience has confirmed our anticipations as to the advantages of the system; the Niagara Bridge, over 900 feet in length, which was manufactured and erected across the rapids in the short time of ten months, having stood all the tests of actual working in the most satisfactory manner.

In the Forth Bridge, each span of 1,710 feet is made up of two cantilevers, projecting 680 feet, and a central girder connecting the same

*Paper read before the Iron and Steel Institute at Glasgow.

350 feet in length. The cantilevers are 343 feet deep over the piers, and 40 feet at the ends. The bottom members consist of a pair of tubes tapering in diameter from 12 feet to 5 feet, and spaced 120 feet apart, centre to centre, at the piers, and 31 feet 6 inches apart at the ends.

The top members consist of a pair of box lattice girders tapering in depth from 12 feet to 5 feet, and spaced 33 feet apart at the piers, and twenty-two feet three inches at the ends Each tube has a maximum gross sectional area of 830 square inches, and each girder a maximum net sectional area of 506 square inches. Upon each cylindrical masonry pier is bolted a bedplate carrying a "skewback," from which spring vertical and diagonal columns and struts. The former are 12 feet in diameter, and from 368 to 486 square inches sectional area: the latter are flattened tubes. Horizontal wind-bracing of lattice girders connect the tubes forming the bottom member of the cantilevers, and similar vertical wind-bracing connects the vertical and diagonal tubes, so that the whole structure is a network of bracing, capable of resisting stresses in any direction, and of any attainable severity.

The rolling load provided for is (1) trains of unlimited length on each line of rails weighing one ton per foot run; (2) trains on each line made up of two engines and tenders, weighing in all 142 tons, at the head of a train of sixty short coal trucks of 15 tons each. The wind provided for is a pressure of 56 pounds per square foot, striking the whole, or any part of the bridge, at any angle with the horizon, the total amount on the main spans being estimated at no less than 7,900 tons. In practice, only two trains, weighing 800 tons in all, would be on this length of bridge at the same time, so the wind pressure (if such a hurricane as 56 pounds per square foot could ever occur), would be ten times as great as the train load. Under the combined stresses resulting from the test load in the worst position, and the heaviest hurricane, the maximum stress on the steel will not exceed 7½ tons per square inch on any portion of the structure, and on members subject to great variation in the intensity and character of stress, the maximum will not exceed 4 tons per square inch. For tubular columns and struts, 34 to 37-ton steel, with an elongation of 17 per cent. in 8 inch, is specified, and for tension members, 30 to 33-ton steel, with 30 per cent. of elongation. We have now about 15,000 tons of steel delivered and worked up, and are satisfied that the quality as supplied to us by the Steel Company of Scotland, and the Landore Company is admirably adapted for bridge construction. In making the tubes, the plates are heated in a gas furnace, and bent hot between dies, in a powerful hydraulic press. A slight distortion takes place in cooling, which is corrected by pressing the plates again when cold. After bending, all four edges are planed, and the plates built up into a tube. Travelling annular drill frames surrounding the tube, fitted each with ten traversing drills, bore the holes at once through plates, covers, and stiffeners, so that when again fitted in place for erection, every piece comes into exact juxtaposition. Similar travelling drill frames deal with the lattice box girders, every hole being drilled as the machine advances. Generally the plant designed by Mr. Arrol for drilling the innumerable holes in the 42,000 tons of steelwork for the main spans is of signal merit ard efficiency, and well worthy the attention on practical engineers.

At the present time, although, as already stated, about 15,000 tons of steelwork is on the ground, only the approach viaduct girders, and some of the bed-plates of the main spans are erected and rivetted up. In a few weeks, however, the erection of the portion of the main spans over the North Queensferry piers will be proceeded with.

The "skewbacks" and connecting tube will first be rivetted up, and then a platform of temporary girders and planking will be constructed, and raised gradually by hydraulic rams in the four vertical 12 feet diameter columns as the work of erection and rivetting up progresses. This platform will carry cranes and other appliances, and the men will be thoroughly protected, so that work may be carried on with as much confidence at a height of 350 feet at sea level. When the portion of steelwork over the piers is erected, the first bay of cantilever on each side of the same will be added, the work forming its own staging. This will be followed by succeeding bays until the cantilevers are complete, and the central girders will be erected, probably on the same plan.

It will be observed that for certain parts of the Forth Bridge we use steel of a higher tensile strength, than is at present considered admissable either for ships or boilers, This has not been done without full and mature consideration of the whole question. Our experiment showed that steel having a tensile strength of from 34 to 37 tons per square inch offered a decided advantage over very mild steel, when compressive stresses and the flexure of long columns were concerned. Indeed, an inferior quality of steel, such as would be used for rails, will stand compression far better than the best boiler steel or Lowmoor iron.

Thus, I found a column 20 diameters in length of common Bessemer steel carry 27 tons per square inch, where one of mild boiler steel has stood but 17 tons. It would be inexpedient, however, to use inferior steel even for the compressive members of a bridge, and therefore a high quality and high tensile resistance were indicated. Although this steel takes a temper and becomes brittle if cooled in certain ways, it will stand the ordinary Admiralty temper tests, bending to a radius of double the thickness, after being made red-hot and cooled in the usual way. In a boiler the steel plates are subject to great changes of temperature and consequent stresses from expansion and contraction. In a ship almost every plate in the hull is subject to alternate tensile and compressive stresses when amongst waves; and further, a vessel is liable to severe alternating stresses and shocks on taking ground, dry docking, and under other circumstances. In the compression members of the Forth Bridge, the steel is subject only to a steady pressure of varying intensity, and a quality o steel was adopted, which combined perfect facility in working with a high resistance to compression. Although an increased tensile strength is accompanied by a decidedly increased resistance to flexure in columns and struts, the latter is not proportional to the former. If the thing were practicable, what I should choose as the material for the compression members of a bridge would be 34 to 37-ton steel, which had been previously squeezed endwise in the direction of the stress to a pressure of about 45 tons per square inch, the steel plates being held in suitable frames to prevent distortion.

My experiments have proved that 37-ton steel so treated will carry as a column as much load as 70-ton steel in the state in which it leaves the rolls, that is to say, not previously pressed endwise. It would be a matter of much practical moment to ascertain if some convenient treatment could be devised which would endow steel with this greatly increased power of resistance to compression without injuring its resistance to tension, or its ductility, which remained unaffected by previous compression in my experiments. At least one-half of the 42,000 tons of steel in the Forth Bridge is in compression, and the same proportion holds good in most bridges, so the importance of gaining an increased resistance of 60 per cent. without any sacrifice in the facility of working and safety belonging to a highly ductile material, can hardly be exaggerated.

Our experience has led us to the conclusion that sheared edges are a more fruitful source of fracture than partial tempering, or other contingencies. All of our bent plates are made red-hot, and the effect of the shearing is thus eliminated even before planing. Those plates which are not heated have the edges carefully planed so as to leave no trace of the shearing, and we find that whether we are dealing with 30-ton or 37-ton steel, the plates so treated stand all the desired tests. Experiments which I have made, and am still making, on the resisting power of different classes of iron and steel to repeated bendings, such as the shaft of a marine engine undergoes if the bearings get out of line, indicate that the superiority of low tension steel is considerably greater than the increased ductility would indicate.

In conclusion, I may state that the approximate value of the plant now at the Forth Bridge is 250,000*l.*, and of the work executed 600,000*l.*

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page* 219).

Grass is the most annoying matter that trackmen have to deal with, it is so energetic and thrifty, that no matter how hard it is fought it persists in growing and marring the appearance of the track. The operation of grassing consists of mowing the right of way and grubbing the track and road-bed. How often this is necessary depends upon the productive qualities of the soil, and the degree of neat appearance required. If perfection is demanded it is necessary to mow right of way twice, andgrub the ditches constantly, and from this standard, practice can be toned down to meet wants to the lowest limit, which is that grass shall not grow so high as to get between wheels and rails to cause slipping. Mowing should be done as late in early summer as possible, so as to make one mowing answer, and just before the weeds are ready to seed down. After mowing, the weeds and grass should be raked together and either removed or burned, for if they are left to dry they are sure to catch fire and carry it to the fence. At the same time as the mowing is done the road-bed should be grubbed of its weeds and small grass, then, unless the ballast is full of loam so as to raise a second crop at once, the next grubbing can be postponed until autumn when the right of way can be mowed if necessary. In cleaning the road-bed out beyond the ends of the ties, the work should be carried to a straight edge to conform with the standard cross section. Mowing is done with different scythes as previously described, and over ordinary ground, and a right of way 66 feet to 100 feet wide, a foreman and six men can mow about one mile per day. Grubbing is done with shovels or grub hoes, and the same force can clean from one-quarter mile to one mile of track per day according to the heaviness of the growth.

To some this cleaning of the road-way appears unnecessary and costly as being for appearance only, and taking time which might be devoted to repairs of track. But there are in its favor practical reasons as well as esthetic. When the grass, weeds and bushes are allowed to grow high they afford a cover for cattle, and prevent those cattle from being seen until they actually step out in front of a train; when this same brush withers and dies under the August sun, it provides copious material for an extensive fire. While on no account is good work to be sacrificed for good appearance by devoting to the latter too great a share of the time, still a certain amount of

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attention must be paid to it, because a slovenly exterior is sure to give a road a poor reputation, on the principle that we are all too apt to judge a man by the coat he wears; so the ordinary layman standing on a station platform or looking out of a car window, and seeing the grass nicely cut, ties in line and the whole right of way in neat and trim order, will be impressed with the idea that the roadbed is in excellent condition, and ride along with the firm belief that the track is perfectly smooth. A railroad man having to deal with large numbers of people should be ever watchful and ready to turn to his advantage their weaknesses, and so oftentimes be enabled to produce a desired impression by giving a pleasing effect to the eye.

A northern climate's snow is the greatest enemy of the trackman, and how to handle it is what every one wants to know. In some localities business must be suspended until the storm is past, while in others less severe, the obstructive material is attached with various kinds of ploughs, and to enter a description of such "outfits" is hardly possible, as each locality requires a different treatment, so we will therefore give a few words on the question in general. The first principle to be observed is to keep ahead of the snow if possible, that is, not to permit the snow to drift and pack and so close the line. This is best done by running ploughs constantly over the track, or else engines with their pilots sheathed, if the regular trains are not close enough together. As soon as a storm is over men should get to work and clear those places offering the most resistence. If the snow is deep a plough should run over the line followed by a "flanging car" (to be hereafter described) or if the fall is light and does not exceed one and a half to two feet the plough can be dispensed with, provided the engine drawing the flanging car has a plough attachment in place of the pilot. This will soon put the main track in good shape. In the meantime track gangs, augmented if necessary, should clean the switches and frogs first, and then the sidings in order of their importance. In case a flanging car is not used the main track must be flanged, that is the snow removed next to the inside of the rails, by hand, and this should follow, unless the force is large enough to do all simultaneously, the cleaning of the switches and frogs and principle sidings. If the snow is deep it is a long and tedious job to flange with the shovel as one man can cover scarcely ½ mile of track per day at best, while the machine can run 15 miles per hour. It is a bad plan to depend on a thaw to remove snow, much better to make sure, and as soon as the track is in running condition to load on cars and remove all snow from yards, narrow cuts and anywhere where it may be an obstruction, and so be ready for the next storm. When cleaning a switch the snow should be entirely removed around the switch apparatus and thence to the heel of the frog, cleaning out the channels of the latter and the space between the guard rail and main rail. In these places between crossing or platform planks and the rail snow soon packs hard and freezes into ice, so as to require slow and tedious picking to cut it out This can be obviated by sprinkling salt, which will keep the snow soft or soften it until such time as it can be removed. One barrel of salt will save much labor and wear of picks.

(TO BE CONTINUED).

SHARES in the Manchester canal project are in great demand. They are put at £10 each, and there have been single applications for £10,000 worth of stock. The expectation is that as soon as the canal is opened, it will obtain a fourth of the tonnage now entering Liverpool—four million tons—which at the low profits of 2s. per ton would would give an annual revenue of £400,000, or 5 per cent. on the capital. The enterprise therefore, has a very enthusiastic backing.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.: M. INST. C. E.

(CONTINUED FROM PAGE 221)

DCCLXXXIV.—WESTCHESTER R. C. PROTECTORY, N.Y.

The Protectory at Westchester New York, about 15 miles from New York City is a large institution for the care of homeless children under the care of the Roman Catholic Church.

Water-works were built in 1880 by the institution, taking the supply from an artesian well of 6½ inch diameter and 485 feet deep, yielding 24,000 gallons daily. The water is pumped by a Knowles Steam deep well pump from a point 200 feet below the surface to two tanks raised 80 feet above the ground. This supply was found to be insufficient and in 1884 another artesian well was bored. This well is 8 inches in diameter and yields 144,000 gallons daily.

The population supplied is 1,408. No further information can be obtained.

Brother Candidus is Rector of the Male Department.

DCCXXXV.—WHITEHALL, N. Y.

Whitehall, Washington Co., New York, in lat, 44° 15′ N., long. 73° 20′ W., is situated at the head of Lake Champlain, and is the terminus of the Champlain Canal.

Water-works were built by the village in 1852, taking the supply from mountain springs the water from which is collected in a reservoir holding 3,000,000 gallons, formed by a dam 260 feet long built across a valley and being about ½ a mile distant from and 266 feet above the lowest part of the village.

In 1884 new works were constructed, part of the supply being now pumped by a Davidson steam pump of 1,500,000 gallons capacity to a reservoir and also directly into the mains.

The distribution of the old works was by 2 miles of wrought and cast-iron pipe, with 2 fire-hydrants and 45 taps, and of the new 8 miles of cast-iron pipe with 50 fire-hydrants. No additional taps have as yet been put in. Galvanized iron is used for services. The works have cost, for the old, $8,000, and the new, $80,000. The bonded debt is $79,000 at 4 per cent. The expenses of maintenance and receipts of the old works have alike been $600 annually. Population in 1880 was 4,270. W. G. C. Wood is secretary of the works.

DCCXXXVI. WILLIAMSTOWN, MASS.

Williamstown, Berkshire Co., Mass., in lat. 45° 42′ N. long., 73° 10′ W. on the Hoosac River, is the seat of William's College, and a favorite summer resort.

It is still unincorporated. Water-works were built in 1859 by a private company, taking the supply from a spring which crops out at the base of a high hill, and is one and a quarter miles distant from, and 30 feet above the village. A reservoir 10 feet long, 8 feet wide, and 6 feet deep, constructed of stone masonry laid in cement, receives the water at the spring, and thence it is conducted to the village in 6-inch cast-iron pipe. Distribution is by three miles of cast-iron pipe with four fire-hydrants, and 200 taps. No meters are used. The daily consumption is unknown. Service pipes are of wrought iron. The village does not pay for fire-service. The works have cost $12,000. There is no debt. The yearly expenses of maintenance do not exceed $10, and the revenue from water rates amounts to $720. The population in 1880 was 984. E. A. Tallmadge is president of the company.

WATER

AUGUSTA, Ga., is complaining of muddy water; some of the citizens want it filtered by "a big machine."

THE Colorado, Texas, water-works, were opened October 1.

THE contract for city water-works at Talladega, Ala., has been closed, and work will begin in sixty days.

D. DULL, contractor, is drilling an Artesian well for Messrs. Seabury & Peters at Brick Church, N. J. The same contractor is also drilling a well at Franklin, N. J., for the Kingsland Paper Co.

THE average quantity of London sewage daily poured into the Thames at the outfalls, may be approximately stated as 700,000 tons, or 157,000,000 gallons, or 25,000,000 cubic feet, or a cube of 293 feet diameter.

THE Bismark, Dak., City Council has passed a resolution accepting the water-works, and declaring them in all respects satisfactory for fire protection.

THE Ferris & Halladay Water-Works of Houlton, Maine, have been put into operation. The pumping engines are two of Worthington's each 5,000,000 capacity.

HOUSE inspection in Richmond, Va., showed lately that the daily waste of water was 250,000 gallons. This city "uses" 8,000,000 per day with a population of about 65,000.

SCHNECTADY, N. Y.—The common council have accepted the report of the water commissioners for th purchase of the water-works for $90,000, and the stockholders of the water company have accepted the terms.

ESTIMATES are now being made as to the probable cost of bringing the mineral water from Chilhowee Springs to Athens, Tenn., and the opinions of eminent scientific men are being received on that subject.

CHATTANOOGA, Tenn., now consumes from two and a half to three million gallons, and during cold weather the consumption will reach nearly 4,000,000 gallons, and larger mains are now being laid.

AN irrigating ditch forty feet wide, five feet deep and forty miles long, is to be dug from the Tuolumne river, near La Grange, on the plains of Stanislaus county, Cal. It will cost $184,000.

GRANVILLE, N .Y., Oct. 5.—An immense water tank which was recently constructed at Granville for the purpose of supplying the village with water, burst today, soon after noon, and caused damage estimated at about $20,000. It is not known what led to the accident.

THE Council of Chicago, Ill., have about decided to appoint a commission of three civil engineers, to investigate and report upon an improved system of drainage and water supply. The amount to be expended for this purpose, is variously stated at from $10,000 to $20,000.

THE reservoir of the Lowell, Mass., water-works, is being cleaned, and when first emptied for this purpose, about 75 feet of the slope wall or paving slid down, and it is expected that other parts may follow. The capacity of the reservoir is 20,000,000 gallons; it was built in 1872, and this is the first time that it has been emptied.

COLUMBUS, Ohio, advertises for bids for a 15,000,000 gallon duplex compound condensing engine, either vertical or horizontal. At the same time they will receive bids for a 4,000,000 engine now in use, until November 30. The present daily consumption of water ranges from 5,000,000 to 12,000,000 gallons, the latter being fire demand.

IN all parts of Westchester County, N. Y., except in the lowest land, wells and springs are dry and stock is suffering for water. Croton Lake has not been so low in years as now, and heavy drafts are being made upon the storage reservoirs and upon Lake Mahopac and tributary lakes.

RACINE, WIS., Sep. 26th.—A meeting of the committee interested in the subject of the artesian well system of water works, was held at the city hall and a committee was appointed to examine into the feasibility and cost of sinking a well, the purchase of a site for a tower and the cost of laying water mains to the city.

THE mineralogists of Washington are keeping a careful watch upon the progress of the great water-works tunnel, which traverses the rocky highlands in the northwestern part of the city, and a series of specimens is to be gathered, at intervals of fifty feet, throughout its entire length of 21,400 feet, for preservation in the National Museum. Already many minerals hitherto unknown in the District of Columbia have been brought to light.

DR. CHAS. N. HEWITT, secretary of the Michigan State Board of Health, has submitted a report of tests made on water taken from the Mississippi river at Minneapolis, at Shingle creek, at the East side pumping station, the intake pipe and city hall. He discovered traces of sewerage in either of the specimens submitted, and his report sustains the analysis made by Prof. W. A. Dodge last winter.

TROY.—Palmer H. Baerman, chief engineer of the water-works, lectured October 2nd., before about forty students of the Rennselaer society of engineers on the waste of water and its prevention. Providence, he said, with a population of 114,000, consumes 3,600,000 gallons of water per day, for which she receives $269,318.77, while Troy, with a population of 60,000, furnishes 9000,000 gallons per day for $72,923.34.

THE irrigation works in Colorado are on a great scale. The Grand river ditch in western Colorado, at the beginning is thirty five feet wide at the bottom, fifty feet wide at the top, five feet deep for the first ten miles, then gradually diminishing until the last two and a half miles are sixteen feet wide at the bottom with three feet depth of water. The grade is a little over twenty-two inches to the mile, which gives it a strong current. One company engaged in the irrigating business has constructed over 100 miles of canal in the Rio Grande valley at a cost of $750,000.

THE little town of Plymouth, Pa., has been summing up the cost of its typhoid fever experience through neglect of its water supply. The price in human lives was 107. There is no way to equate that in terms of money. The cost in dollars was nearly $60,000 in extra expenditure, and about the same sum in loss of wages from enforced idleness among the sick and those who had to wait upon and nurse the sick—in all about $120,000. Costly experience that for a little town like Plymouth; but the remaining consideration is, Will the people there profit by it?—*Philadelphia Ledger.*

A PIECE of intelligence was recently received at the Mining Exchange in New York, which created some excitement among the holders of the Comstock properties, namely, the determination of the Sutro Company to utilize the immense body of water flowing from the tunnel, to drive quartz mills for crushing the low grade ore several hundred feet west from its mouth. The fall from the mouth of the tunnel to the mouth of the Carson river is about 168 feet, and the calculation is that with this power five 40-stamp mills can be erected with a total crushing power of 600 tons in 24 hours. The ledge of the low, grade ore cut through in driving the tunnel is said to be between 400 and 500 feet in width, and to give an average assay of nearly $5 per ton. The building of trestles for flumes and tracks and the construction of the mills is to begin at once.

THE proportion of iron in all the wells at Saratoga, N. Y., is as follows:

Springs.	Proportion of iron.
High Rock	0.135
Congress	0.031
Hathorn	0.101
Empire	0.079
Columbian	0 638
Pavilion	0.233
United States	0.065
Seltzer	0.155
Geyser	0.089
Star	0.110
Eureka	0.375
Excelsior	0.402
Hamilton	0.578
Crystal	0.185

PACIFIC OCEAN WATER IN NEVADA.—There is said to be a curious warm spring in Newark Valley White Pine County, Nevada. It pours out of the mountain, and affords about fifty inches of water. The water is almost tepid when it first reaches the surface. Along with the rushing torrent of water, there is a continuous flow of small sea shells of every size and description. The flow of water is never affected by the seasons as other springs in all parts of Nevada are known to be. Whether the season be wet or dry, there is no change. There is also another curious feature about it. These variations average about four inches, and are as regular as the sun itself. Can it be that there is a deep subterranean connection between this spring and the Pacific Ocean? It certainly behaves that way, and those who have watched it for years have come to the conclusion that there is.—*Pittsburgh Dispatch.*

THE Camden Iron Works will deliver to the Nashville, Tenn., within the next 45 water works days, all of he main water pipe. This costs, there being something over 4,000 tons at $24.30 a ton, about $100,000. There have been paid about $30,000 and the other $70,000 will be due and payable within the forty-five days.

Foster & Creighton, contractors for the laying of the pipe, are now engaged with a large force on the work, and large weekly payments are being made to them. They will complete this work before or by the first of the year, and their entire contract price, in the neighborhood of $25,000, will then have been paid them.

Hicks, Holmes & Co., are now engaged with a large force at work on the island filter and pump house, and payments are being made on this as the work progresses.

The price of the new boilers at the water-works, which is $10,000, will be due in a few days, and will come out of this fund.

The City Council have been asked by the Board of Public Works for authority to make a partial payment of $50,000 to the Holly Manufacturing Co., on the satisfactory delivery of the new pumps and engine, bought by the former administration. This will be acted on at the next meeting of the council. Work on the water-works is being pushed forward with the utmost rapidity.

PLYMOUTH, N. H., Sept., 29.—Plymouth Aqueduct and Water Company to-night brought suit as the culmination of the trouble extending over a year. Last year the company failed to furnish water on account of the drought. Several times the water was entirely shut off when repairs were needed. The firewards claimed a deduction on this account, and tendered the company about $100 less than the rental, which was refused. A special meeting of the precincts authorized the firewards to submit the question for arbitration. The company refused to accept the proposition, claiming the entire amount of the rental. They notified the precincts that they should consider the contract abrogated, and within a reasonable time shut off the water, causing great indignation. The suit will be bitterly fought.

ACCORDING to Prof. Tyndall's investigations, the singularly blue color of the water of the Lake of Geneva is due to the presence of small mineral particles, probably derived from glacier dust, brought into the lake by drainage from glacier streams, and of such extreme minuteness as not to settle even when the water is allowed to stand for a long time. Examination also makes apparent the fact that not only is the light mainly blue from the first moment of its reflection from the minute particles, but the less refrangible elements which always accompany the blue are still further abstracted during the transmission of the scattered light by true molecular absorption. These two causes, scattering and absorption, are therefore considered sufficient to account satisfactorily for the exceptional blueness of both the Lake of Geneva and the Mediterranean Sea.

POND ENGINEERING COMPANY, ST. LOUIS.—No firm in the West is better known in connection with the designing and erecting of improved pumping machinery for water-works than the Pond Engineering Company doing business at 707 and 709 Market street, this city, having fitted out some twenty Western cities with pumping machinery. The company being engineers as well as contractors, they are prepared to give purchasers the benefit of their training and experience in planning the work. This saves the expense of additional experts and consulting engineers. Their contracts usually include boilers, furnaces, pumping engines, condensing apparatus, boiler feed pumps, feed water heaters, pipe connections—in fact all details of the steam plant, erected and started, ready to be turned over to the purchasers in complete operation.

The pumping machinery handled by this firm is built by the Geo. F. Blake Manfacturing Company, of New York and Boston. These works have constructed pumping engines for some of the largest cities in the world, including St. Petersburgh, Tamboff and Kief, Russia; Washington, D. C.; New Orleans, La.; Duluth, Minn., etc. The following Western cities are provided with their machinery: Lexington, Sedalia, Rich Hill, Hannibal and Mexico, Missouri, East St. Louis, Greenville, Paris and Danville, Illinois, Columbus, Victoria, and Laredo, Texas, Mason City, Mount Pleasant and Fort Madison, Iowa.—*Age of Steel.*

WATER PIPE ASSESSMENTS.—The City Councils of Harrisburgh, Pa., are now discussing the mode of water-pipe assessments, and the manner in which they are to be paid. The chief clause in the proposed law under consideration, reads as follows: "That whenever any pipes or conveyance of water shall be laid in any street or highway within this city, the owners of the ground in front whereof the same shall be laid, shall pay for the expense thereof the sum of 25 cents for each foot of their ground upon such street or highway: *Provided:* That on all corner lots an allowance shall be made of one-third the length of their front, but such allowance shall be always and only on the street or highway having the longest front, and in case both fronts are equal, the allowance shall be made in the highway in which the pipe shall be last laid. If the corner lot shall have enclosed upon it two or more separate tenement allowance shall only be made of one-third the corner tenement and yard appurtenant, but in no case shall the allowance exceed sixty feet. All such assessments shall be prepared by the city engineer, who shall attach thereto a map or plan showing the points and amount assessed upon each. No credit or abatement shall be allowed by reason of any assessment pursuant to the provisions of this ordinance for or on any account whatsoever."

THE SOUTH BETHLEHEM WATER WORKS.

Since 1875 the borough of South Bethlehem has been supplied with water drawn from the Lehigh river below the town. (For description of this system see No. 275 in Croes' History of American W. W.) Last spring the Bethlehem South Gas & Water Co. undertook the construction of a new water supply system, which will draw the water from the river above the town. Bethlehem has its own water supply, and this new system is to supply South Bethlehem and West Bethlehem.

The new works include a pumping station and reservoir. The pumping station is situated about ¼ mile west of the Bethlehem depot on the L. V. R. R. It is on the south bank of the river and about 20 feet north of the L. V. track. About 500 feet further up, the river is divided into channels by Calypso Island, and the water will be drawn from the south channel. At this point the river has an elevation of 217 feet above sea level.

A stone crib, into which opens a 24" pipe, is built in the river, about 60 feet from shore. This pipe conducts the water to a well under the pump house. The well is to be 4' wide, about 6' deep and 40' long. The pipe has a fall of 6" in the 60 feet from the crib to the well and is laid 6" under the river bed.

The pump house is to be on a foundation which will raise the floor 23 feet above the water. It will be 42 feet long, 25 feet wide and 20 feet high, with walls 15 feet thick and built of stone. On the west end will be built the boiler house, having a length of 38 feet, width of 40 feet and height the same as the pump house.

The pump is being made by the Dickson Mfg. Co. of Scranton, Pa. It will be compound, vertical-acting, with a capacity of 1,500,000 gallons per day. A vertical acting pump was chosen because of the great distance from the water up to the floor of the pump house.

From the pumping station a 12" main leads south 1200 feet and to an elevation of 455 feet above the sea level, where it empties into the reservoir. This elevation gives sufficient head to force the water to all parts of West Bethlehem and to all places south of the river, where it would be used, except Packer Hill of Lehigh University. Here the water can be forced into the first and second stories, but not into the third.

The reservoir will have two compartments, each calculated to hold 1,000,000 gallons when standing at a depth of 12 feet. These compartments are separated by an embankment 6 feet wide on top, and 70 feet at the base. One of them will be nearly rectangular in slope, the length on the bottom being 131 feet, and width 52 feet, with sides sloping 2 to 1. The other is more irregular in form, one side being 105 feet, the opposite one 42 feet and the other two 112 feet and 93 feet.

The sides and bottom are to be covered with a foot of puddled clay and then with an equal thickness of concrete. All pipes leading to and from the reservoir are also to be packed in puddled clay.

The distributing pipe for the first ¼ mile is 16" diameter. This reaches to the river bank about 250 feet below the pump house. Here it branches, and a 12" pipe passes under both channels of the river, crosses Calypso Island and under the Lehigh Canal to West Bethlehem, while a 10" pipe turns east to South Bethlehem. The pipes are all laid 4 feet under ground.

In the purification of the water, the subsidence process will be used; the water being pumped into one compartment of the reservoir and allowed to settle, then drawn into the other, from whence it will flow to the town.

The contract for the construction of the pumping station and reservoir was given to Brown & Goodnow, engineers, of Bethlehem. They have been at work since the middle of April with a force of about 100 men. Most of the excavating for the reservoir is done and one compartment partly puddled. At the pumping station the crib is nearly finished and the rock is rapidly being blasted away for the foundation of the pump house. The cost of the work completed will be about $60,000.

NEWS OF THE WEEK.

Contracting.

League Island Dry Dock.—Congress will be asked to appropriate $700,000 for the construction of a dry dock at League Island, Philadelphia about, 700 feet in length, suited to the dimensions of the new cruisers.

New York City.—The Department of Public Parks will receive bids until October 21st, for the excavation, drainage, and masonry etc., for the enlargement of the Metropolitan Museum, Central Park.

The International Dredging and Contract Company, of Nashville, Tenn., has been incorporated to do a general dredging and construction business. Capital stock $5,000,000.

Turning Out Steel Rails.—PUEBLO, Colorado, September 29.—The Bessemer Steel Works are in full blast, pounding away on that 1,000-ton steel rail contract for the Denver & Rio Grande Railway. All the departments of the works except the blast furnace are in operation.

R. R. Contract Let.—The contract for building twenty-eight miles of the St. Cloud & Willmar road from St. Cloud to Cold Springs, has been let to D. C Shepard & Co., of St. Paul. Foley Bros. of St. Cloud have taken a sub-contract from Shepard & Co.

Newark, N. J., Sewers and Drainage.—The common Council Committee on Sewers, have awarded the contract for the construction of a sewer in Fillmore street to Satchwell & Bellingham for $1.40 per foot, $30 for manholes and $100 each for basins.

Dredging at Bangor, Me.—Moore and Wright of Portland, to whom the contract was given to dredge the harbor at Bangor, Me., employed the dredger Bothfield of the Eastern Dredging Company, of Boston to do the work. This machine was constructed at a cost of $50,000. Up to date it has removed from the harbor 29300 cubic feet of material. It has yet to displace 190,000 cubic feet and is carrying out at the rate of about four scow loads per day. It is what is called in medium grade digging. The work will be completed, it is thought by the first of November. Mr. O. H. Wright is superintendent of the operations.

CANVASS OF BIDS FOR BUILDING FISHER HILL RESERVOIR received September 29, 1885.

		Trumbull & Cheney, Lawrence and Chelsea	Moulton & O'Mahoney, Lawrence.	Patrick Grace, Brighton.	Charles Linehan, Cambridge.	T. F. & J. J. Maney, Boston.	O'Connor, Webb & Batchelder, Boston and Worcester.	J. H. Leavitt, Boston.	R. A. Malone, Lancaster, Pa.	W. H. Ward, Lowell.	Parker and Sylvester, Boston.	Willcutt & Perkins, Boston.	Boynton Bros., Boston.	G. W. Hendrick, Easthampton.	Hugh Nawn, Boston.
	cu. yds														
(a.) Earth Excavation	77,000	$ 0.40	$ 0.41	$ 0.55	$ 0.44	$ 0.625	$ 0.70	$ 0.55	$ 0.75	$ 0.70	$ 0.82	$ 0.76	$ 0.75	$ 0.75	$ 1.65
(b.) Rock	200	1.00	1.25	1.50	0.50	1.80	3.50	3.00	1.00	2.00	2.00	4.00	4.00	2.00	5.00
(c.) Puddling clay deliv'd.	3,242	2.25	2.30	2.42	2.00	1.90	1.00	3.00	3.00	3.00	2.25	3.50	3.00	3.00	2.50
(d.) Bottom puddle	6,550	0.45	0.48	0.56	1.25	0.40	0.50	0.75	0.75	1.00	1.00	1.10	1.80	3.00	1.75
(e.) Slope "	6,450	0.52	0.54	0.6	1.75	0.50	0.50	1.00	1.00	1.50	1.00	1.50	1.50	3.00	2.25
(f.) Ballast	1,830	2.50	2.70	2.4	2.50	2.40	2.00	2.90	2.00	3.00	3.00	2.00	2.50	2.00	4.00
(g.) Stone, slope paving	1,120	3.50	3.57	3.5[illegible]	4.00	3.00	2.00	5.50	3.60	4.00	5.00	3.80	7.50	6.00	8.00
(h.) American Cement Concrete	595	5.50	5.52	5.60	4.50	4.75	6.00	5.87	4.00	6.00	5.50	6.00	8.00	8.00	5.00
(i.) Portland Cement	1,350	7.50	7.62	6.50	6.50	6.75	6.50	8.50	5.50	8.00	7.50	8.00	10.50	8 00	10.00
(j.) Brick masonry	130	11.00	10.00	15.00	15.00	15.00	14.00	13.00	10.00	12.00	15.00	14.00	14.00	15.00	12.00
(k.) Rubblestone masonry	400	8.50	9.00	10.00	6.00	10.00	8.00	11.00	7.00	8.00	8.50	9.50	10.00	10.00	25.00
(l.) Dimension do. do. 6 cut faces	22	35.00	38.00	45.00	50.00	30.00	36.00	40.00	35.00	30.00	50.00	40.00	48.00	40.00	50.00
(m.) Dimension do. do. quarry faces.	43	22.00	22.50	35.00	25.00	25.00	18.00	21.00	30.00	25.00	30.00	30.00	40.00	16.00	30.00
	sq. yds														
(n.) Coal-tar concrete	1,550	0.90	0.75	1.10	1.00	1.10	3.00	1.00	1.00	0.50	0.70	1.00	1.00	2.00	5.50
	lin. ft.														
(o.) Laying 36-inch pipe	240	0.30	0.27	0.75	1.00	1.00	0.75	0.87	1.00	1.00	1.00	0.40	2.00	1.00	2.50
(p.) Laying 16-inch pipe	90	0.16	0.15	0.50	0.50	0.50	0.40	0.87	1.00	0.50	1.00	0.30	1.37	1.00	2.00
	Total.	74,130.90	75,606.30	87,727.64	88,491.50	89,523.05	93,619.00	99,772.35	103,623.50	111,726.00	117,092.00	118,876.00	131,840.30	143,204.60	217,790.

Canal Work to Cost Over $1,000,000.—OTTAWA, September 29.—The government engineers have completed plans for the enlargement of the Welland canal to a fourteen foot draft, to enable a large class of vessels to pass down to the lakes and the St. Lawrence river from Chicago to Montreal with lightering. The work will cost over $1,000,000 and tenders for carrying it out will at once be called for.

The New Prices for Coal.—PHILADELPHIA, Oct. 3.—The Philadelphia and Reading Coal and Iron Company has issued a circular of Eastern prices, being the first tariff published since last June. The rates in effect at that time are generally restored except on chestnut and pea, the former being 25 cents lower at both Port Richmond and Elizabethport, and the latter 10 cents lower at Port Richmond and 20 cents lower at Elizabethport than in June. The new rates for white ash coal delivered on board vessels at Port Richmond for shipment beyond the Delaware Capes are $4 for lump and steamboat, $3.25 for broken and egg, $3.85 for stove, $3.15 for chestnut, and $2.10 for pea. The prices at Elizabethport, N. J., are $4.25 for lump and steamboat, $3.50 for broken and egg, $3.40 for chestnut, $4.10 for stove, and $2.35 for pea.

Granite Block Paving.—The New Haven, Conn., Board of Public Works has instructed the city engineer to procure from the Smith Granite Company at Westerly, L. I., enough granite blocks for paving Meadow street, provided the stone can be furnished in season to complete the paving by November 10th. This contract will require about 130,000 blocks, and the Smith Granite Company has informed the board that it can deliver 90,000 blocks in that city the present week, and will supply all that are needed at $1.65 per square yard. G. Pohlman, who was present by request, stated that he could lay the blocks in from twelve to fourteen working days and would superintend the work for $5 per day and charge $4.50 per day for paving men, $3.50 for rammers, and $1.50 per day for laborers. The board voted to employ Mr. Pohlman.

Little Rock, Ark., Jail.—Bids were opened at Little Rock, Ark., Oct. 1st., for the new jail for Pulaski county. The following were the bids.

Entire Building.

Snead & Co. Iron Works, of Louisville	$19,840
C. W. Clark, Little Rock	19,950
Casey & Simms, Little Rock	19,825
Noah Hamlett, Little Rock	19,740

Building without Iron and Steel Work.

Noah Hamlett	$11,966
Pettefer Bros., Little Rock	10,490
Patrick Powers	10,300

Iron and Steel Work.

Diebold Safe and Lock Co., Canton, O	$ 7,960.00
Van Dorne Iron Works, Cleveland	8,000.00
Hall Safe and Lock Co., with swell centered rivet	8,080,27
Hall Safe and Dock Co., without swell centered rivet, but with rivets upset	7,761.54
Ætna Iron Works, Quincy, Ill	8,097.00
Fred J. Myers Manufacturing Co., Covington Ky	5,410,00
Snead & Co., Iron Works, Louisville	7,774.00
The Pauli Jail Building and Manufacturing Co., of St. Louis	6,500.00
H. A. Streeter, of Chicago	10,423.00

Thus the jail will cost $16,990. The plan of the building was furnished by Mr. Bartlett, and bidders made their own specifications. The contract was awarded to Messrs Pettefer Bros., of Little Rock, for the building, and the Pauli Jail Building and Manufacturing Company of St. Louis.

New Torpedo Boats.—The torpedo boat, David Bushnell, to be used in laying torpedoes and wires at Willett's point, was launched at the Continental Iron Works lately. She measures on the keel 82 feet. The hull is composite, having a steel frame of angle bars 18 inches apart, 5-inch steel deck beams. She has a pair of inclined engines, the diameter of cylinder being 14 inches and the stroke 15 inches, which can be run at either high or low pressure. The boiler, which is made of steel, is of the return tubular pattern, 10 feet long 8½ feet in diameter. It can carry 100 pounds of steam. The engine, reversible propeller and small engine are all worked directly from the pilot-house. The engineer has nothing to do with working the engine. The Mallory propellor-wheel enables the boat to turn on its own center. The propellor-shaft is within a circular box which is under water at the stern of the boat. This box can be turned at will by the pilot, and thus point the propellor-wheel in any direction.

Work Commenced.—Work has been begun on the McPherson, Kan. extention of the Newton and El Dorado R. R.

Ead's Ship Railway.—EL PASO, TEX., September 25.—A bill passed the Mexican Congress to-day allowing the Eads Ship Railway Company one-third of the vacant lands resulting from a survey of the Tehuantepec route.

Electric Engines.—Charlotte, Ga., is soon to have a line of street cars propelled by electricity instead of by horses. The line is to be built by a Chicago firm, who will furnish the electric engines to propel the cars Work, it is said, will soon be commenced.

Telegraph Line.—G. E. Knight & Co., of Milwaukee, have received the contract from the Wisconsin Central Company to construct their telegraph from Schleisingerville to Chicago, a distance of 110 miles. Work will be commenced immediately. The construction will cost about $200 per mile.

Repairing the Falls Bridge.—The Philadelphia Councils Committee on Highways, October 2nd, opened proposals for rebuilding the Northern span of the Falls bridge. George Oberholtzer & Co., offered to do the work at $12,974. The other bidders were G. F. & M. Eyre, at $8,725. As the amounts were in excess of the money on hand, the schedule was referred to the chief for further action.

A Floating Fire Department.—A flotilla of about a dozen steam tugs, furnished with powerful Knowles and "Niagara" pumps for fire-extinguishing purposes, was organized not long ago for service on the water front, by the Pennsylvania Railroad Company, and the system was found to work admirably at the recent fire on the Rotterdam steamship pier in Jersey City. Besides the pumps several of the tugs are fitted with what is known as the "D. A. Woodhouse Siamese coupling," a device whereby several of the streams may be forced through one nozzle of great volume and strength.

To Bridge the Mississippi at Memphis.—Articles of association have been filed in the Secretary of State's office of the Tennessee and Arkansas Bridge Company. The object of the company is to build a bridge, truss or suspension, across the Mississippi river at or near Memphis and Hopefield. The charter is to be good for ninety-nine years, and the capital stock is $5,000,000, of which $1,000 is paid in. The directors and stockholders are William G. Ford of Westwood, Ark., and associates of New York, $2,625,000; Rees B. Edmonson of Crittendon county, $25,000; James C. Saunders of Fort Smith, $25,000; W. G. Ford, Jr., of Lee county, $25,000; Robert A. Burton of Little Rock, $1250.

Newark, N. J.—A contract for the sewering of Sherman street has been awarded to Michael Curley, for the construction of the sewer at the foot of the Newark Avenue Hill, to connect with the Sixth street main, to P. J. Condon.

To Bridge the Galena River.—GALENA, ILL., September 27.—The bridge now being constructed by the Chicago, Burlington and Northern Company over Galena River at the point known as the cut-off, is to be a draw, with a 250 foot span, a little over twenty feet less than that of the Dubuque and Dunleith bridge over the Mississippi. It is to be one of the finest structures of the kind in the West, and will be completed before Christmas of this year.

The South Pennsylvania.—CHAMBERSBURG, PENN., Oct. 5.—A short time ago the contractors along the South Pennsylvania Railroad received word from the American Construction Company asking what amount of money they would take for the work done on the road by them. They sent in their figures, and on Saturday word was received by them that their propositions had been accepted and they were ordered to discontinue work on the tunnels at once. This morning all the hands were discharged and work was generally suspended. The Kittatinny tunnel, over 4,000 feet in length, was almost completed. The contractors say they have the assurance that the road will be completed by the Pennsylvania Railroad.

Construction Contracts.—JACKSON, TENN., September 26.—The contract for bridging and grading the extension of the Yazoo and Mississippi Valley Road was let here to-day by Capt. J. G. Mann, Chief Engineer. The road is a branch of the Illinois Central, is to be seventy miles long and extends from Yazoo City to a point opposite Grenada. The building of the road will cost about $1,000,000. It is to be built through a swampy country, and the bridging contracts, which will be the heaviest part of the cost were let: Thirty miles to Sewell & McPherson, Boonville, Mo.; ten miles to J. C. Neely, Boxdell, Ky.; eighteen miles to J. H. Bethune, Charleston, Mo.; twelve miles to J. M. Gardy, Springfield, Mo. Work will commence in a few days.

Work on the Cascada Division N. P. R. R.—A Portland (Oregon) special says: "Gen. Anderson, Chief Engineer of the Northern Pacific, asked as to whether work was to be continued on the Cascade Division, said that on the eastern side of the as Cascades operations would be continued as work could be prosecuted during the winter. The road is completed for a distance of 93 miles from the Columbia River and 30 miles of additional grading are nearly completed, though there is some heavy work to be done yet. This brings the end of the graded portion of the road to Ellensburg. Work on the west side will be continued until the 25 miles now under construction from South Prairie are completed. There will then probably be a stoppage for the winter. No further contracts have been made for construction on the western side of the Cascade Mountains."

The Chalmers Spence Co., of New York City, in a new and handsome catalogue, call renewed attention to their non-conducting coverings, asbestos products and fire-proof materials. All the higher grades of coverings made by this company contain from 25 to 100 per cent. of pure asbestos fibre, making the most durable goods of the kind known. They are also now placing on the market a new composition for covering pipes, etc., made by combining infusorial earth with asbestos fibre; the product has great structural strength and durability and is applied on a wire frame surrounding the pipe in such manner as to leave an air-space about the hot pipe. Their patent removable covering, asbestos mill-board, gaskets, etc., are special features; and it will pay consumers to know all about hem by sending for a catalogue.

A Canadian Pacific Branch.—Mr. L. A. Sénécal has signed the contract for the construction of a line of railway to be built from the Piles on the St. Maurice river to Lake St. John. A branch of the Canadian Pacific already runs from Three Rivers to that point and the contemplated extension covers about fifty miles.

Work will be commenced as soon as arrangements are made with the Canadian Pacific Railway for an interchange of traffic. Proposals are now before that company.

A subsidy is offered by the Provincial Government to the company which reaches Lake Edward first.

Newport and Covington Bridge, Kentucky.—The Board of Directors of the Newport and Covington, O., Bridge Company met September 29th, for the purpose of receiving the report of the expert engineers, Messrs. Bouscaren and Morton, to whom the bids for the proposed new bridge were referred, all the members being present.

The report was presented and read. The conclusions of the experts are as follows:

"For design for cantilever truss you have two bids, namely: From the Keystone Bridge Company, $68,800: from the Lomas Forge and Bridge Company, $77,500.

The Keystone Bridge Company's bid is the lowest by $8,700. This design is fully equal in character of excellence to design No. 2, and affords the advantage of being a little cheaper, and of allowing the erection to proceed without risk from and regardless of floods in the river; in addition thereto the particular design submitted by the Keystone Bridge Company would allow the erection to proceed with the least interruption to travel.

For these reasons the undersigned recommend that the cantilever design submitted by the Keystone Bridge Company be adopted, and the contract for the construction of the same be awarded to the Keystone Bridge Company on its bid of $68,800."

The contractors will not commence until next March.

The New Pension Building, Washington, D. C.—The last iron beam of the roofs of the new Pension Building is now in place, at a height of 150 feet. The roof of the central hall, 316 by 116 feet, has been erected while the building has been occupied by the Pension Bureau, with a gradually increasing force, and the middle section, the highest 116 feet square, has been built, over 1,200 clerks busily occupied in the business office. The contractors and their workmen deserve credit for the skill and intelligence which accomplish this result without accident or injury to life or limb.

Bridge Bids, Springfield, Ohio.—Bids for the superstructure of the Spring street bridge Springfield, Ohio, were as follows: Canton Bridge Company, $4,321·60; Columbia Bridge Company, of Dayton, $4,784; Mt. Vernon Bridge Company, $4,307; Smith Bridge Company, $4,380.07; the bid of the Smith Bridge Company, which was the lowest, was for a bridge of a capacity of 2,080 pounds per linear foot, while that of the Canton Bridge Company was for a bridge having a capacity of 2,500 pounds per linear foot. The bid of the latter company was recommended for adoption, and a resolution to that effect passed.

The Davis Island Dam, was formally opened on October 8th. This dam, on the Ohio, six miles below Pittsburg, Pa., designed to maintain a navigable stage of water at that city the year round, was begun August 18, 1878, and since then, with many interruptions and delays, the National Government has spent nearly $1,000,000 on the structure. The dam's distinctive feature is its movability. It is in reality 300 little dams, each so hinged that it can lie prone upon the river bed. This line of movable dams, or "wickets," extends the entire distance across the river, 1223 feet. Of this distance, 559 feet only is the navigable pass or pathway for all craft when the lock is not used. The rest of the dam is designated as "weirs," of which there are three, divided by solid piers of masonry. To raise the wickets of the navigable pass a "manœuvring boat" is used; to raise the "weir" wickets a "surface bridge" is called into play.

Like the wickets, this bridge lies upon the bed of the river when not in use and is raised and joined section by section. To raise the wickets and tilt them into position, where they are retained by a prop, calls into play an ingenious device, the Pasqueau "hurter." A deft pull upon the prop dislodges it and permits the wicket to recline upon the bed wrested from the river. Between each wicket is a space of an inch or two, which can be batted from the upper side if desired, but which will probably be left open to permit the passage of surplus water.

The monster gates of the lock are closed by force generated in a turbine wheel fed by water stored in huge tanks. Each gate rolls upon its track and when in position they form the upper and lower extremes of a lock 110 feet wide and 600 feet long; a space sufficient to accommodate a tow-boat and average tow of canal-boats and barges. To fill the lock requires but four minutes' time; to empty it the same.

The great dam is experimental, in that, should its success be assured, others will follow, and a series of pools will render the Ohio steadily navigable, as has been the case on the Monongahela.

Milwaukee Bridges.—The Board of Public Works yesterday opened bids for constructing the superstructure of Kinnickinnic avenue bridge, as follows: Penn Bridge Company, of Beaver Falls, Pa., $5,850; A. T. Riddell, Milwaukee, $7,495; John Ward, Clinton, Ia., $9,000. The proposals, which are deemed very reasonable, will be submitted to the Common Council, at the meeting Monday evening.

Railroads, Bridges and Canals.

New Line.—The chief engineer of the Rome and Chattanooga railroad says that the contract will be let at an early day for building the line from Rome to Trion, nearly half the distance.

Manhattan & Blue Valley.—It is the intention of the Union Pacific Company to extend the Manhattan and Blue Valley to a connection with the other Blue Valley line at Marysville at once. Arrangements have been made for the work.

Grant to a Railroad.—The Dominion Government has agreed, with the approval of the English capitalists interested in the scheme, to give the proposed Chignecto Marine Railroad Company a grant of $172,300 per year for twenty-five years as originally proposed.

Boundary Survey—BUENOS AYRES, Oct. 2.—A treaty has been arranged between the Minister of Foreign Affairs and the Brazilian Minister for the survey of the frontiers of Brzil and the Argentine Confederation, Both governments will form a commission to settle the boundary questions.

The Kansas and Colorado Midland Railroad.—It will construct and operate a standard gauge railroad from Kansas City to Denver. The business will be transacted at Winfield. The directors are J. L. Horning, J. C. Long and M. L. Robinson, Winfield; H. W. Hall, New York; L. S. Olmstead, J. L. Morrison and B. F. Beesly, of Jacksonville, Ill. The capital stock is $16,000,000.

Double Rails.—According to the Joliet (Ill.) *News* the Joliet Steel Company now roll steel rails in two-rail lengths, thus saving two crop ends on every two rails, as well as securing a larger product than by the old method of rolling single rails. The company intend to roll four-rail lengths after awhile. The rails are passed through the rolls by machinery.

Denver, Memphis and Atlantic.—Messrs. Fitzgerald and Mallory, contractors, are making arrangements for commencing the work of grading the road from Bell Plain, twenty-five miles, to Winfield, Kan., and also for the work of track-laying which begun at Conway Springs, Sumner County.

TOPEKA, Kan., September 28th.—It has been ascertained that the bonds voted the Denver, Memphis and Atlantic railroad along their projected line from Baxter Springs to Kingman are worthless, inasmuch as they were voted for a standard gauge railway, whereas the Denver, Memphis and Atlantic, on account of a defect in their charter, has no legal existence except as a narrow gauge railroad. Their old charter was under the name of the Denver, Memphis and Atlantic narrow gauge railway. Instead of filing a new charter, the stockholders voted to change the corporate name to the Denver, Memphis and Atlantic railway, but neglected to change in the body of the charter the words "narrow gauge" into "standard gauge."

Market Report of Engineering Materials.

New York, October 8, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles	1.9c. @	2.2c.
Tee	2.2 @	2.4c.
Beams and channels American	3.0c. @	
Tank	2. @	2.1c
Shell	2.4c. @	2.5c
Steel plates, Tank	2¾c. @	3c.
WROUGHT-IRON PIPE, PITTSBURGH.		
Butt welded, black, Discount	42½ @	45
" galvanized "	35	
Lap welded black "	60 @	62½
" Galvanized "	45	
Boiler tubes "	57½	
RAILS.		
Steel (large lots at mill)	29.00 @	30.00
Old rails	17.25 @	17.50
Old rail steel	17.00 @	18.00
R R. spikes	1.8 @	1.9
R R, splice-plates	1.65 @	1.7.
R R. Track Bolts Square Nuts	2.55 @	2.65
Barb-wire fencing, galvanized		4.50
" painted		3.50
Corrugated iron		
Nails		
Iron	2.50 @	2.60
Steel	2.65 @	2.75

METALS.

COPPER.		
Lake Superior	11 @	11¼
Other Brands	10¾ @	11¼
LEAD.		
Com. Domestic	4.25	
Lead Pipe	.05¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
ZINC.		
Sheet	5.75 @	6.00

BRICK.

(Cargoes afloat)		
Haverstraw per M.	$5.50 @	6.00
Fishkill		
Up-River	5.00 @	5.75
Jerseys	4.50 @	5.25
Long Island		
" pale	2.75 @	3.25
FRONTS.		
Croton red	11.00 @	14.00
" dark	11.00 @	14.00
" brown	10.00 @	13.00
Philadelphia pressed	24.00 @	25.00
Trenton "	24.00 @	25.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	65.00 @	130.00
" American	85.00 @	120.00
Fire brick	25.00 @	40.00

CEMENT.

PORTLAND.		
Gibb's English 400 lbs. per bbl	2.75 @	2.90
K. B. & S. " "	2.85 @	3.00
J. B. White & Bros., Portland Cement	2.65 @	3.00
do Keene's Superfine,	8.00 @	10.00
do " Coarse,	5.00 @	6.00
Roman "	2.75 @	3.50
Largerdorfer German "	2,55 @	2 80
Dyckerhoff, " "	2.90 @	3.25
Stettiner " "	2.60 @	2.65
Hanover " "	2.60 @	2.65
Vorwohler, Lion "	2,90 @	3.25
Alsen, " "	2.55 @	2.60
Fieve "	2.40 @	2.50
Saylor's American	2.15 @	2.40
Windsor, Standard, U. S. C. Co.	1.00 @	1.10
		1.15
Cable's Portland	2.15 @	2.40
F. O. Norton		1.10
ROSENDALE cements	90 @	1.00

LIME.

Rockland common per bbl	1.00	
" finishing	1.20	
State, common	.90	
" finishing	1.10	
Kingston, ground	0.95	
Add 25c. to above figures for yard rates.		

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.90 @	95
" " No. 2 "	0.75 @	0.80
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " " "	0.75 @	1.00
Brownstone, Portland, Ct. "	1.00 @	1.30
" Belleville, N. J. "	0.75 @	1.25
Granite, rough	0.60 @	1.25
Common building stone per load	2.00 @	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00 @	20.0
" Choice "	55.00 @	80.
Tally plank, 1¼ in. 10 in. dres'd, each.	.44 @	.50
Tally boards, dressed com. "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	20.00 @	22.00
HEMLOCK, Boards each.	.18 @	.20
Joist, 2½ × 4 to 4 × 6 in	.17 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00 @	40.00
YELLOW PINE, Girders "	25.00 @	30.00
Dressed flooring "	28.00 @	35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75 @	6.00
LATH, Cargo rate	2.10 @	2.25

PAINT.

Lead, white, American dry per lb	.04¾ @	.05
" " in oil pure "	.05½ @	.05¾
English, B. B. in oil	.08½ @	.08¾
Red, American	.05½ @	.05¾
Litharge "	.05 @	.05¼
Venetian red, American "	.01 @	.01¾
Indian red "	.05 @	.10
Vermillion, American lead "	.11 @	.11½
Paris green "	.15 @	.19
Umber, Amer. raw and powdered per lb.	.01¼ @	.01½
Drop black, Amer.	.08 @	.12
" "	.09 @	.11½
Chrome green	.05 @	.15
Oxide zinc, American	.03¾ @	.04
" French	.06¼ @	.06½

New Road.—At a meeting held at Dixon's Springs in the interest of the Middle and East Tennessee Railroad, which will connect with the Nashville and Chattanooga and tap the Cincinnati Southern at Sunbright, rights of way were given and a large amount of stock subscribed. The building of the road is almost an assured fact.